THE WORLD IS ITS FIELD.

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THE GROWTH OF AMERICAN COAL EXPORTS.

By Frederick Edward Saward.

ON October, 1900, Mr. Saward's widely quoted article on "The World's Need of Coal and the United States' Supplies" was published in this Magazine. Probably there has never been a period of equal length so tensely filled with industrial interest as the fourteen months intervening. The attention of the manufacturing world has been centred upon the manifest tendency to a shifting of the seat of supremacy in the steel trade. But already it is beginning to be clear that any system which will strongly handle and control the steel output, so as to avoid the depletion of the iron reserve, (which depletion Mr. Hull ably showed in our issue for August, 1900, is intimately connected with industrial depressions) is widely beneficial to the whole world. Back of the steel industry, even more elementally important to material progress, lies the fuel industry. If the United States can serve as a storage battery of this fundamental form of power, able to correct the serious and crippling fluctuations caused by overload on Europe's long-depended-upon stores, the ultimate result will be a highly profitable stability for manufacturers everywhere. It is in this light that a new and thoroughly contemporaneous review of American coal-export possibilities is of very great importance.—THE EDITORS.

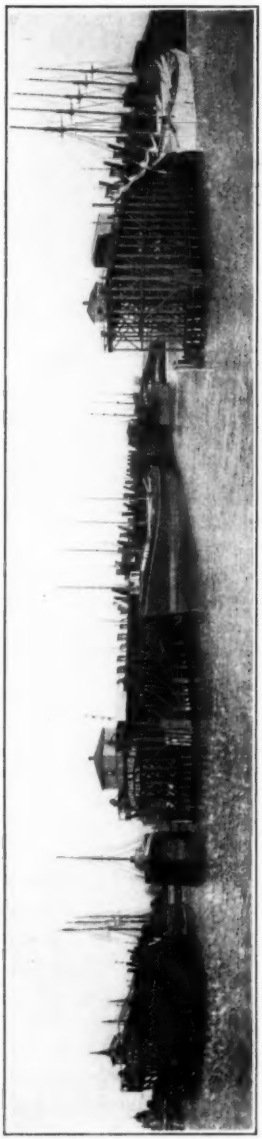
IMPORTANT and highly significant developments in the American coal trade have recently been attracting world-wide attention. Not only have the great coal-producing and coal-carrying railroads of the eastern States been brought together, and, by the "community of ownership" plan, placed under the control of powerful financial interests, but a variety of factors in combination have brought the possibility for a large increase in the export of the bituminous product. Within the most recent period America has been shipping anthracite to Europe, also. As the exporting of coal increases it will add millions yearly to the annual income of the country. That American coal is destined to compete with the coals of England and Wales in the markets of the world is unquestioned, and the bituminous or soft coal produced in Pennsylvania, West Virginia, and Alabama is already finding markets abroad. Pennsylvania produces for the seaboard trade what is known as Clearfield coal, originating mostly on the line of the Pennsylvania Railroad, but also reaching market over the Philadelphia and Reading Railway; then there is the coal on the Alleghenies, and to the westward is the Pittsburg district; some coal from the eastern portion of this district reaches tidewater by rail over the Pennsylvania. Pittsburg coal has also a large market at New Orleans, some 1,700,000 tons being sent there during certain portions of the year when water transportation to the port of New Orleans can be had via the Ohio and Mississippi rivers. The disposition on the part of steamship owners to coal up in American ports, owing to the prices being less than those ruling elsewhere, has led to a large increase in the business at this port, and an extensive "bunkering" trade is done in Pittsburg coal at New Orleans, based on a rate of but $3.60 per ton f. o. b.

The steam vessels carrying mules, forage, etc., for the British government to South America, took on very liberal supplies of coal at this port; Alabama coal is also had there for steamship use, coming to the Mississippi at Greenville, and being there transferred by barge to New Orleans and selling at the same price as the Pittsburg coal. With the improvement of the Warrior river by slack-watering, now under way, there will be a supply of Alabama coal for steamship use at Mobile, or at New Orleans, at a considerably less figure. The introduction of oil as fuel on the Gulf ports has as yet made no inroads on the coal trade. At Pensacola, there has been loaded a very considerable tonnage of Alabama coal for export to the Mexican railway systems, and this trade would seem to belong naturally to the coal producers of Alabama.

A TRAIN OF 50-TON COAL CARS ON THE BALTIMORE & OHIO RAILROAD.
Illustrating one of the important factors in the cheap transport of American coal.

The famous Cumberland coal is a decidedly soft coal, breaking into small pieces rather than crumbling, and this would not be in favor with foreign consumers, notwithstanding its richness in fuel properties, as that trade demands a lumpy coal; at the same time this coal is a favorite for bunker or steamship use on the trip across the ocean from Baltimore, and the Fairmont coal of West Virginia is largely shipped in cargo lots abroad. There has been within the past year a considerable tonnage of Cumberland coal, in cargo lots, for the use of the United States Navy, sent to the Philippines, to Yokohama, and to the new coaling station at Pichilique bay on the Pacific, so that the United States Navy now uses the product of American mines, instead of being compelled to buy and use foreign coal, upon foreign or colonial stations.

The coal received from the American coal mines comes in railway cars of forty to fifty tons capacity, which run on to a high trestle, and the largest vessels are speedily loaded with coal at any condition of the tide, with very little labor and with a minimum amount of breakage. Such loading ports are Lambert's Point, Norfolk Harbor, where the Norfolk and Western Railroad has two large piers, with between twenty-five and twenty-eight feet of water at low tide,



CHESAPEAKE AND OHIO RAILWAY'S COAL-LOADING PIERS AT NEWPORT NEWS, SHOWING THE EXTENT OF THE TERMINAL FACILITIES AND EQUIPMENT.

and where coal from the Pocahontas region of West Virginia is loaded for all points of the world. I am informed that more than 300,000 tons of bunker coal were loaded there last year, and that will be doubled in 1901. Across Hampton Roads, where the depth of water reaches sixty-five feet at the end of the coal wharves, the tidewater terminus of the Chesapeake and Ohio Railway has two wharves of very large capacity, and there tonnage has been loaded for many foreign ports, such as Montevideo, Uruguay; Marseilles, France; Piræus, Greece; Algiers, Africa; Vera Cruz, Mexico; Trieste, Austria; Antwerp, Belgium; Kingston, Jamaica; Hamburg, Germany. The terminus of the Pennsylvania line at Canton, Baltimore, affords opportunity for Clearfield coal for bunker purposes to a very great extent, while the Baltimore and Ohio has the very large coal pier at Curtis Bay, especially for the export trade, and here the very valuable coal (from an export point of view) mined in the Clarksburg and Fairmount regions of West Virginia, on the line of the Baltimore and Ohio, is transferred from car to vessel. The erection of this pier is a significant recognition of the present state of affairs, and dating from October 15, 1901, all the export business goes over this pier. Philadelphia has not been behind hand in the export business, and there are two important coal-shipping points—Greenwich, the terminus of the Pennsylvania Railroad, and Port Richmond, where the Philadelphia and

Reading Railroad coal is transferred. Bunker coal alone in Philadelphia is said to amount to 500,000 tons annually. Some recent foreign shipments were to France, Germany, Italy, Scotland, Newfoundland, Mexico, British West Indies, Cuba, Danish West Indies, Haiti, Santo Domingo, and Brazil; at the rate of say 750,000 tons a year.

At New York the soft-coal-shipping wharves are:—South Amboy, of the Pennsylvania Railroad; Perth Amboy, Lehigh Valley property; Port Reading, owned by the Philadelphia and Reading; St. George, Staten Island, owned by the Baltimore and Ohio; Port Liberty, Jersey City, used for shipping Beech Creek coal, and Harsimus piers, Jersey City, owned by the Pennsylvania Railroad. From these New York piers there has always been a very large business done in supplying bunker coal to foreign-going steamers, the coal being brought in barges to the vessels, and it is fully equal to 2,500,000 tons a year; the export trade in cargo lots is either done direct at the wharves referred to or delivered from barges alongside the vessels.

Waterways are not to be ignored, even in a country of vast railroad systems. The tonnage of the Monongahela River is now seven-ninths of that of the Suez Canal, and with the development of the new coal fields of the upper pools the United States engineer in charge of the improvements on the river is certain that in a few years the tonnage will equal that of the great eastern waterway. He is also positive that the Government, after having expended over $4,500,000 to establish a free slack-water system, will endeavor to afford every facility possible for the transportation of coal, and as soon as the tonnage warrants increasing the size of the upper dams it will be done.

For the fiscal year ending June 30, 1901, 6,000,000 tons of coal passed through the locks of the Monongahela river, and of this amount 2,500,000 tons were used in the Pittsburg markets. In addition to the coal there is a vast tonnage of general merchandise, and the operators of the upper pools say the traffic is enough to warrant immediate action by the Government in the matter of increasing the size of the upper locks. While the initial fight is being made on dam No. 6, it is understood that the operators intend formulating plans for an improvement of the entire upper streams in order that the new coal field can be given every facility for shipping its product.

For the improvement of dam No. 6, $18,500 has just been appropriated and the single lock lengthened so that a tow 190 feet in length can be passed through at once. Major Powell favors double locks where the traffic demands it. In his recommendation for the new lock at dam No. 5, $480,000 was asked, and of this amount $295,000 was to

be expended on the lock alone. For a new lock at No. 6 the cost would probably amount to more.

Another of the waterways of the United States which has been improved at the expense of the Government is the Great Kanawha. The river is navigable by means of locks and dams, of which there are ten; eight of these are "moveable" dams, being so constructed that they can be put up and down. These dams are kept up when it is necessary to do so to make coal-boat depth (6½ feet), and down when there is water enough running in the river to make this depth without the dams; by putting up the dams a slack-water canal is formed, thus directing all navigation to the locks. At such times as the locks are not used their uprights are thrown to the bottom of the river and the moveable parts housed at the river side until low water comes again, thus affording unobstructed navigation. The fall in this river is said to be ordinarily about one foot to the mile; the distance from mouth to head of navigable water is about 72 miles; the dams begin at No. 2 and number down stream to 11, inclusive, the levels varying in length from 17 miles, in lock 11, to 5 or 6; a fair average, however, would be about 7 miles. The two upper dams (Nos. 2 and 3) are of the ordinary fixed type, like those on the Monongahela River. The locks are of sufficient length and breadth to admit four barges, two abreast, and thus the fleets are locked through.

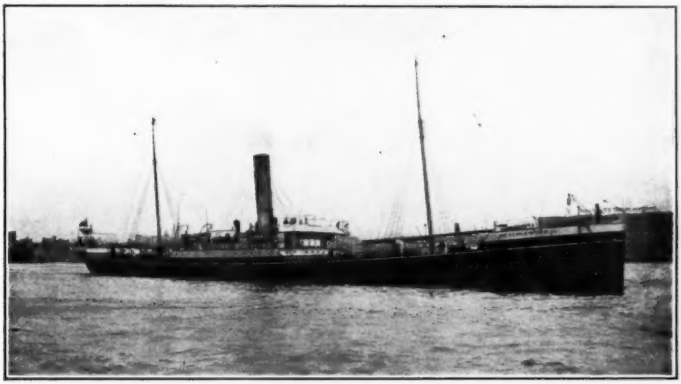
To show the increase of coal traffic on this waterway one may go back to 1875 and note the comparative tonnage since that time up to and including 1900, viz:—

	Bushels.	Tons.
1875	4,048,300	161,932
1885	17,812,323	712,493
1890	24,161,554	966,462
1895	21,982,600	879,304
1900	30,837,000	1,233,480

On the Big Sandy river in West Virginia, the Government has begun the slack-watering after the manner of the Kanawha. One dam has been completed, and there will be twenty-one others before the river and the Louisa and Tug Fork branches thereof are ready in full for navigation. The Big Sandy forks at 28 miles from the Ohio into the two streams named; one is to be made navigable for 71 miles and the other for 80 miles. This will open up an immense territory embracing hundreds of thousands of acres of coal and timber lands—enough coal to supply the northwestern States for 200 years is a modest estimate. The Norfolk & Western Railroad draws a little coal out of the eastern end of the country drained by the streams named, but there

is acreage along their course which can be profitably worked only by having water connections, owing to the peculiarly rough country.

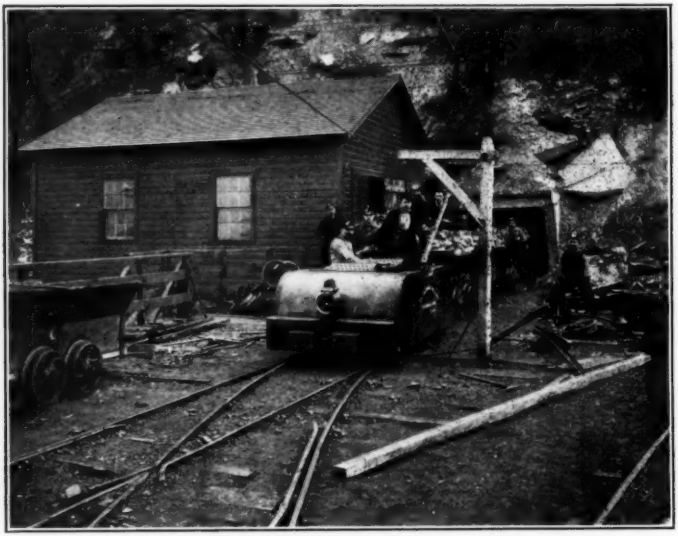
Within the past few weeks there seems to have been a better opportunity for sending out coal from the United States—both anthracite and bituminous—owing to the reduced rates at which vessels could be had for its transportation. On the 5th October, the first full cargo of anthracite ever shipped to Germany was sent in the British steamer Ormesby from Port Richmond, Philadelphia. The cargo consisted of about 3,734 tons of mixed stove and nut, the proportion of the latter size being one-third. It was mined and shipped by the



A CARGO OF AMERICAN COAL LEAVING BALTIMORE IN THE BRITISH STEAMSHIP WESTMINSTER.

5,256 gross tons, shipped May 9, 1899, for Dewey's fleet at Manila. The largest cargo loaded out from Baltimore.

Philadelphia and Reading Coal and Iron Company, and since then other cargoes have followed, making a total business to the port of Stettin, Germany, of 11,000 tons for the past month. The opportunity came when the vessel could be secured at a 10s. 6d. ($2.60) freight. Equal to 18s. ($4.50) was paid for the coal, and the cargo will thus stand in 28s. 6d. at Stettin. As Welsh anthracite is 27s. f. o. b. Swansea, and the freight is 5s., this would make the c. i. f. price at Stettin 32s., or 3s. 6d., equal to 87 cents, more than that of American coal under the present low freight rate from the States. In addition to this tonnage, a very large business is likely to be done with Berlin, via Hamburg, as a prominent merchant of that city has recently decided to visit the United States looking to the development of a trade in anthracite for the city named; he has had offers of vessel freights from New York to Hamburg at 7s., or $1.75 per ton, and



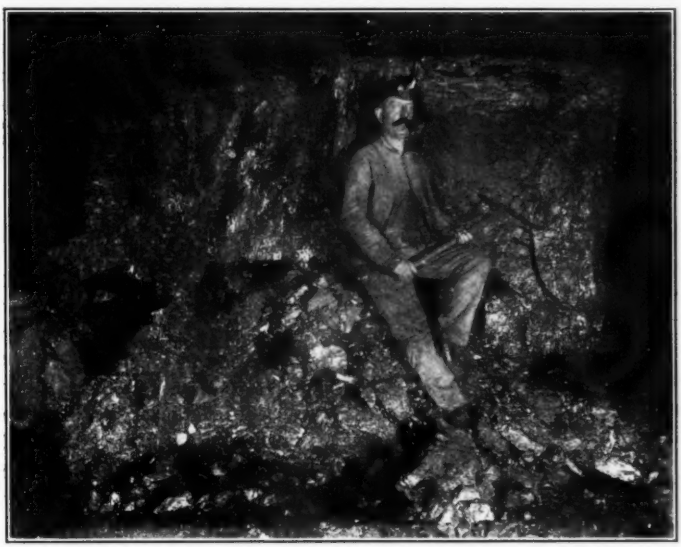
NATURAL AND MECHANICAL ADVANTAGES OF COAL MINING IN THE UNITED STATES.
Electric locomotive drawing loaded cars from a horizontal entry.

on this basis could do a business of something like 200,000 tons annually. The preference with the European shipper or handler of anthracite seems to be for lump coal—to be broken down to size on arrival. Anthracite has also been sent from America to Bordeaux.

The importance of the recent shipments of anthracite from the United States to Bordeaux, Hamburg and Rotterdam can be easily appreciated. Not alone is this a *bona fide* attempt to introduce American anthracite into the German market as a substitute for the Welsh coal of the same character, but it is being effected through the medium of the established lines trading between Philadelphia and these ports. If a rate of freight is obtainable which will admit of these consignments, it is fair to assume that future business can be made on the same basis, and thus a regular trade with Germany opened up. The outcome of this new German business will be awaited with interest. One of the largest merchants in Berlin, says, in regard to these shipments: "Heretofore no American anthracite has ever come to Germany, but we think that we should be able to begin with about 100,000 to 200,000 tons a year, as the anthracite consumption is growing with us every year. There is none in our country, and England offers so short a supply and at such high prices that our big consumers are really anx-

ious to draw at least a part of their supply from the United States." The possibilities of the future will be in the creation of an American collier's fleet, just as much as the English collier's fleet means the force of the British coal-export trade.

Shipments of anthracite from the United States have heretofore been to Canada and Nova Scotia mainly, with a few small lots to Cuba, but the exports of bituminous are growing every week of late, as low freight rates can be had to the continent and to other places formerly supplied from British ports; and of so wide a character is this trade that on the same day shipments are noted from Atlantic coast loading ports to the Mediterranean and to San Francisco. Tonnage has been done to Genoa, Marseilles, Piræus, Algiers, St. Nazaire. Trinidad, Stettin, Colon, Trieste, Antwerp, Hamburg, Tampico, Coronel, St. Pierre, Rio Janeiro, Montevideo, Vera Cruz, Kingston, and Manila. The latest rates of freight are quoted herewith:—$1.40 to $1.45 to Havana or Matanzas; $1.50 to $1.55 to Cienfuegos; $2.00 to Cardenas or Sagua; $1.75 to St. Lucia or St. Thomas; $1.60 to $1.70 to Kingston; $1.70 to $1.75 to Port Spain, Trinidad; $1.85 to Bermuda; $2.25 to Demerara; $1.50 to $1.60 to Tampico or Vera Cruz; 14s. to 14s. 3d. to Rio; 9s. 3d. to 9s. 5d. to a direct port in the Medi-



A FACTOR OF CHEAP COAL MINING IN THE UNITED STATES. PICK MINING IN A VEIN OF SOFT COAL 10 FEET THICK.

terranean; 8s. 6d. to 9s. to Bordeaux, St. Nazaire or Havre; $5.75 to $6.00 to Manila, Yokohama, or Nagasaki. One of the latest tests of American soft coal was on the French cruiser D'Estrées, which escorted the Duke and Duchess of York from Halifax to Quebec and put in at New York port to fill her bunkers; the engineer's report to his Government will develop orders to fill up the bunkers of French warships in North Atlantic waters with American fuel. Nova Scotia is also looking to a development of a foreign trade, and the Dominion Coal Company has an agent abroad for that purpose.

The United States output of coal now exceeds that of Great Britain, which country up to two years ago was the largest producer in the world, and the total of all grades will be 275,000,000 net tons this year. The whole trend of public discussion in England is of the conservation of her coal supplies, and at the Glasgow meeting of the British Institution of Mining Engineers, Sir William Thomas Lewis, president thereof, in his address, said: "With reference to the number of tons of coal unworked in our different coal fields, it is, of course, easy to calculate from the plans and sections of the seams proved, making the usual allowances for faults and loss in working; but the important question is, how many of the seams can be assumed to be workable to a profit from time to time, and how much of the coal contained in the various seams can be usefully obtained? If the thin seams cannot now be worked, while we have superior coals in thick seams to mix with them, I fear that many of the thinner and the inferior coals are much less likely to be profitably worked in the future." The industrial supremacy of the United States is being increased in many of the products of mine, forest, and workshop, and in none more earnestly than in the matter of coal; this will no doubt be handled in many of the foreign ports by English houses, already established for so many years and having all the facilities for doing business in the Continental and other ports, and this will give the opportunity for the conservation of British coal, which is produced at greater cost than American because of the depths to which it is now necessary to extend the workings and the greater cost of labor per ton, there being little other than manual labor employed in the extraction of the coal at British pits. On the contrary, a large tonnage in the United States is mined by machinery; the great increase in machine-mined product in the United States—i. e., 168 per cent. in the last five years—is the best evidence obtainable of the economic advantages thereby secured in raising coal, and there is no doubt that British collieries would derive great benefit by following the American example in the more general

A DRIFT MINE IN THE SOFT-COAL REGION OF THE EASTERN UNITED STATES.

The natural advantages are apparent. No pit mining, shaft sinking, raising, or pumping is necessary. The entry takes a double line of standard-gauge railway; the water flows away by gravity.

adoption of coal-getting by electric- or by compressed-air-driven machines. The number of mechanical coal-cutters employed in the United Kingdom during 1900 was only 311, of which 240 were driven by compressed air and 71 by electricity, the quantity of coal so obtained amounting only to 3,312,000 tons; while in the bituminous-coal districts of the United States there were 3,125 mechanical cutters used at collieries employing above 100,000 persons, which yielded an output of about 45,000,000 gross tons. It is this cutting by machinery that enables the American producer to put his coal on cars in Pennsylvania at 95 cents a ton, and in West Virginia at 80 cents a ton.

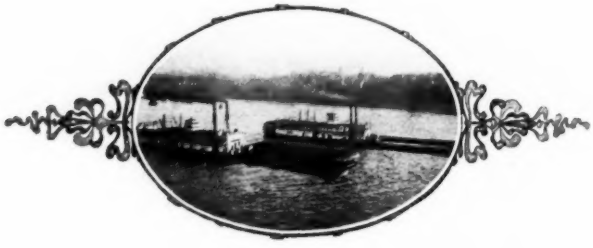
A year ago, when the possibility of the exploitation of an American export trade was spoken of, the rate of ocean freight was decidedly against the doing of any extended business—being quoted at 20s. to the Mediterranean—although the ruling American prices of $2.50 to $3.00 per ton f. o. b. were half what was being asked at the Welsh loading ports; at the latest advices, best Welsh coal was quoted at $4.32 to $4.56 per ton, while freights to Marseilles are put at $1.25, to Genoa $1.32 to Rio $3.12. A new feature in this connection is the

report that a line of colliers will probably be established to ply between Newport News and Marseilles. Up to date there seems to be almost an over-supply of foreign vessels willing to engage in the coal trade from the western side of the Atlantic.

The striking feature of this development is the evidence it seems to afford that the ability of the workers in the United States is greater, and the product per man and machine in excess of anything abroad; the output per employee, in soft-coal mining, was 579 tons in 1900, while the product of each mining machine in use is put at 13,000 tons for the same year. There have been many causes for this, but none equal to the intelligent labor coupled with the disposition to make use of the most advanced appliances in every line.

The export of coal from the United States would appear larger, if the coal put on steamers for bunker use was included. In Great Britain and in France all coal for the use of steamers engaged in the foreign trade is included in the exports in the official returns, although separated as to items and quantities, while coal for the use of steamers engaged in the home or coasting trade is excluded. The principle in Germany is to exclude all coal put on board vessels to be used as bunker coal from the import and export accounts. In Great Britain, the coal shipped for the use of steamers in the foreign trade amounted in 1899 to 12,226,801 tons, and in 1900 to 11,752,316 tons.

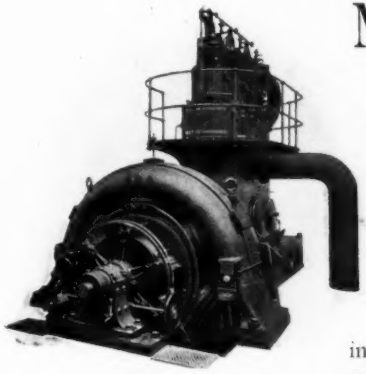
It is futile for American coal producers to think that "anything will do for the foreigner"; care should be taken to gain a good impression in the shipment of coal, if a success is looked for. United States exporters should devote their efforts to shipping first-class mineral, in lumps and duly screened, so as to compete successfully with the English product. As a rule, people on the continent of Europe will be adverse to a change, unless they actually find it is to their great advantage both for quality and price.



ENGLISH, AMERICAN, AND CONTINENTAL STEAM ENGINEERING.

By Philip Dawson.

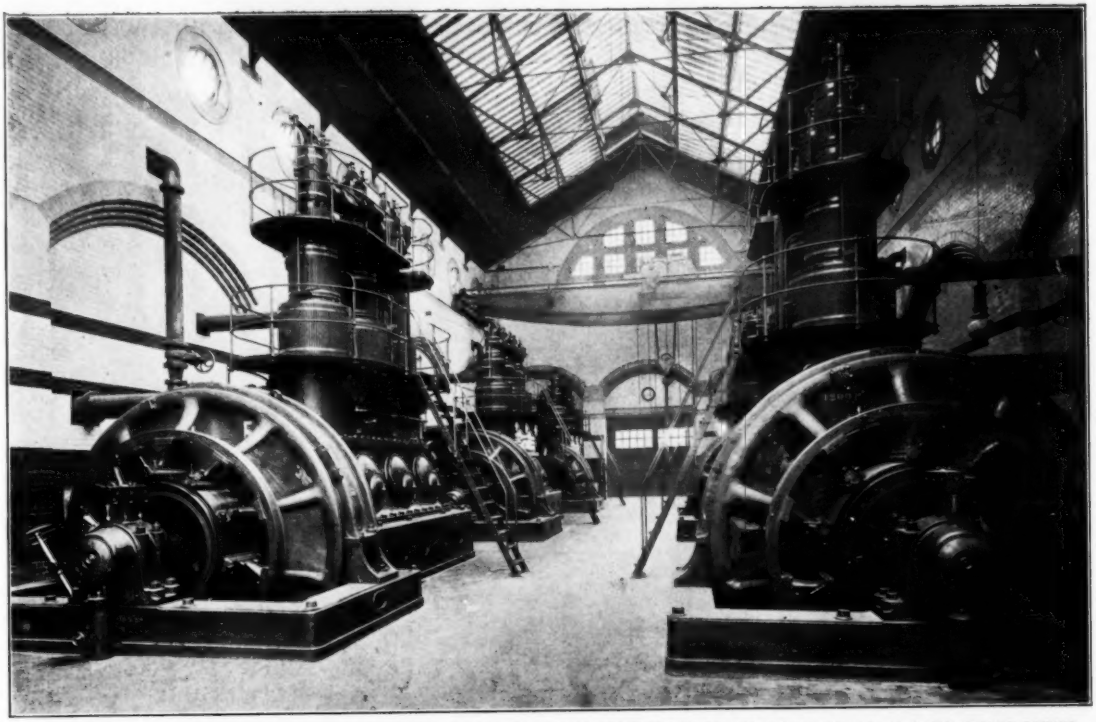
Mr. Dawson's first article appeared in THE ENGINEERING MAGAZINE for November last. The article in this issue will be followed by a discussion of American practice, and a concluding paper will treat of steam engineering on the Continent of Europe.—THE EDITORS.



MY preceding paper dealt generally with the leading characteristics of British, Continental, and American steam engineers and their work, and with British steam-engine practice in particular as displayed by the construction of some of the leading engine-building firms. I may now present the subject from an even more comprehensive point of view by brief description of a few of the most important British electric-lighting and traction plants using high-speed engines.

Pumpfields Station, Liverpool. The engine room is 247 feet long, 52 feet wide, and 37 feet high to the eaves of the roof. The boiler house is in two parts, one part on each side of the engine room, each 51 feet wide, 247 feet long, and 26 feet high to the eaves. The engine-room floor is composed of steel joists and concrete. Each boiler house is furnished with a brick chimney stack 220 feet high, having an internal diameter of 12 feet 9 inches at the top. A coal conveyor supplies the boilers with coal. The boilers are of the Lancashire type, 30 feet long and 8 feet in diameter, with flues 38 inches in diameter. There are fourteen in each boiler house, making twenty-eight in all. Mechanical stokers of the Vicars or Hodgkinson pattern are employed.

The engines are of Willans vertical type, nine-cylinder triple-expansion compound, running at 230 revolutions per minute and giving a continuous output of 1,200 indicated horse power, or 1,500 for short periods. There are three cranks set at 120 degrees, and the crank shaft is 11 inches in diameter. The cylinders measure 15 inches



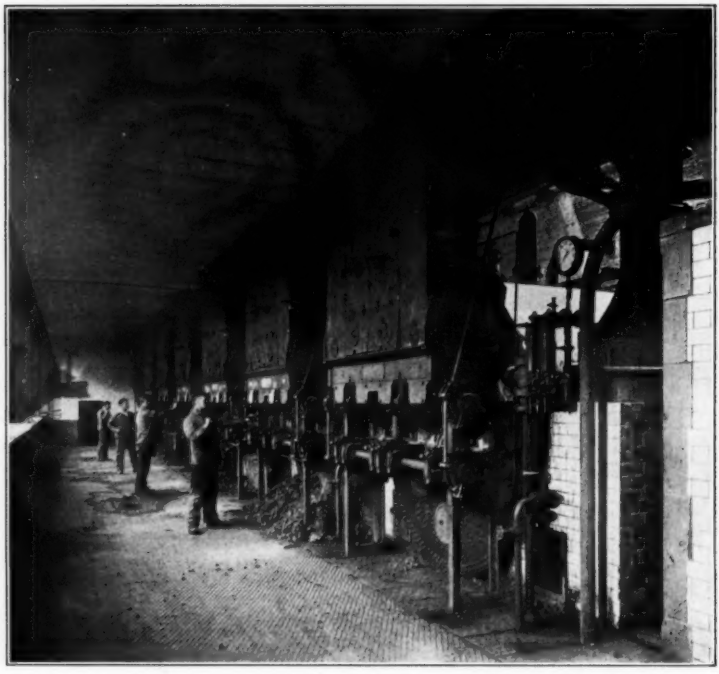
GENERAL VIEW OF WILLANS ENGINES IN THE LIVERPOOL CORPORATION STATION; EACH TRACTION SET IS OF 1,200 HORSE POWER.

20½ inches, and 34⅝ inches, by 16⅞ inches stroke. The governor is of the high-speed type with speed-regulating adjustment, and automatic expansion gear is provided. The crank chamber is completely enclosed, and the lubrication of all the working parts is by splash, no lubricators or oil pumps being required. The bearings are lined with white metal. There are twelve engines in all.

PUMPFIELDS STATION, LIVERPOOL.

The engines are direct-coupled to Siemens multipolar shunt-wound self-excited dynamos, which give 1,420 amperes at 550 volts. Each machine is mounted upon a bed plate which is rigidly connected to the engine bed plate. The armature shaft is carried at one end by a flanged connection to the crank shaft, and at the other end by a massive bearing attached to the bed plate. The armature serves instead of a flywheel for the engine.

Hull Electric Tramways. The electric tramways at Hull furnish another example of high-speed direct-coupled units being employed for traction work. The steam-generating plant consists of four Lancashire boilers, 30 feet long and 8 feet diameter, fired by Vicars mechanical stokers; the working pressure is 150 pounds per square inch. A Green's economiser having a heat surface of 2,618 square feet is also installed. The engine room measures 83 feet by 44 feet, and contains three Bellis engines each direct-coupled to a Siemens bipolar dynamo. The engines are of the ordinary vertical enclosed double-acting type, with automatic forced lubrication; they are designed to develop 470 indicated horse power at normal load with steam at 140 pounds per square inch, when running condensing at 360 revolutions per minute; 700 indicated horse power can however be obtained for short periods.



LANCASHIRE BOILERS AND MECHANICAL STOKERS, PUMPFIELDS STATION, LIVERPOOL.

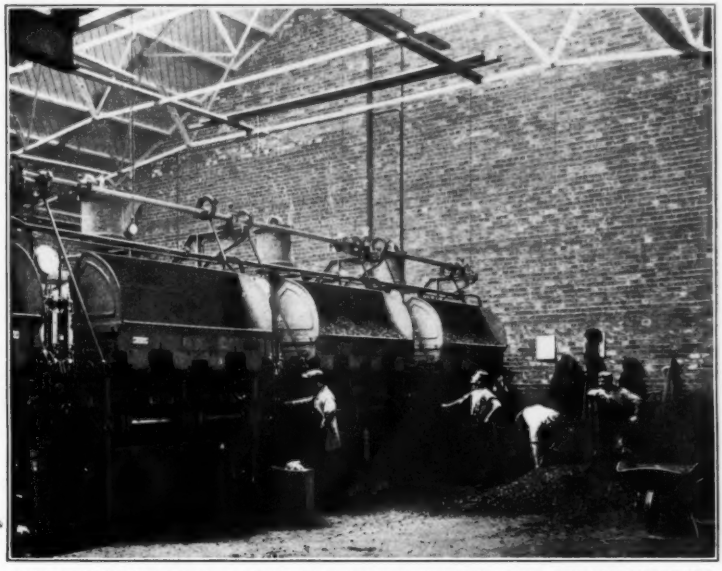
The engine really consists of three compound tandem engines, working onto one shaft, the three cranks being at 120 degrees with one another. The speed is governed by a shaft governor which actuates a throttle valve. Each of the dynamos is designed for an output of 550 amperes at 500-550 volts. The armature is not bolted direct to the flywheel, and there is a bearing between the two, on account of the great weight of the flywheel.

This is a typical British type of station, the high-speed engines, two-pole dynamos, and Lancashire boilers all being used. Two-pole machines are, however, dying out at last, and their place is being taken by multipolar machines, which are becoming standard practice.

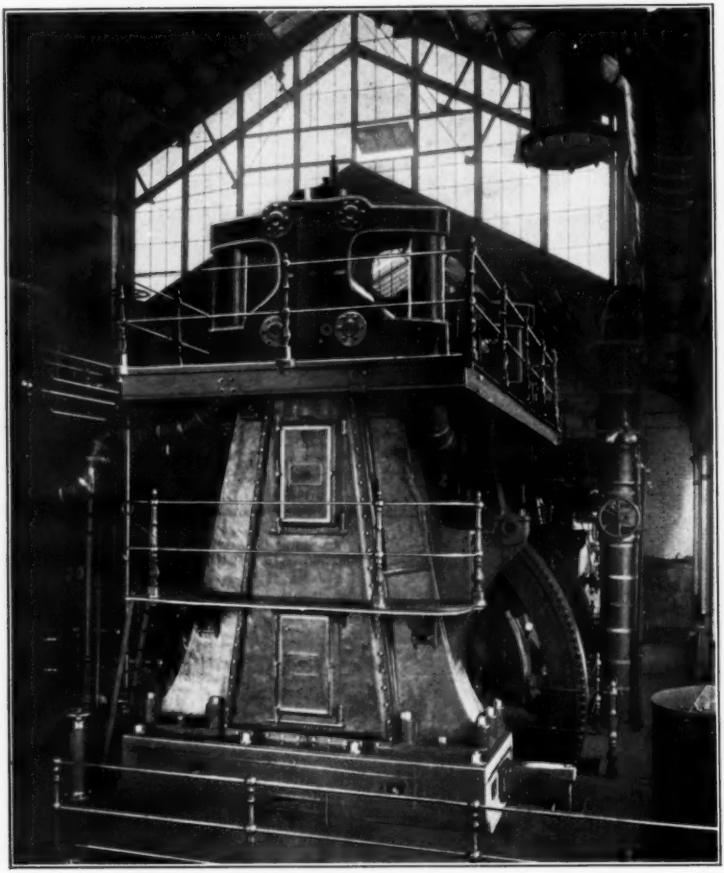
The Ferranti steam engines are generally of the vertical cross-compound enclosed type, and run at or near 250 revolutions per minute. Both cylinders, including the covers, are steam-jacketed. Balanced slide valves actuated by link motion are employed for the steam distribution; on the high-pressure side this gives automatic control,

while the cut-off on the low-pressure is adjusted by hand. The speed is governed by a high-speed spring-loaded governor. The crank-shaft bearings, of which there are two, are of the spherical type. There is no special flywheel, as the rotating part of the alternator serves instead, being mounted on the shaft between the high- and low-pressure cylinders.

It is practically only quite recently that slow-speed direct-coupled sets have been used in Great Britain, and in this respect the country is behind the Continent and United States; doubtless the backwardness of electric traction is responsible for this. There are in the United Kingdom well-known slow-speed-engine makers, such as Yates & Thom, Musgraves, Hick Hargreaves, Galloways, Robeys, Barber & Combe, Adamsons, etc., but most probably it was the advent of the American Reynolds-Corliss engine, more than anything else, which caused the awakening of the manufacturers to the large field open before them and to the necessity of building a slow-speed engine which would answer the requirements of electric-traction engineers. The conditions under which engines for electric traction have to run are very trying and differ in many ways from those which have to be



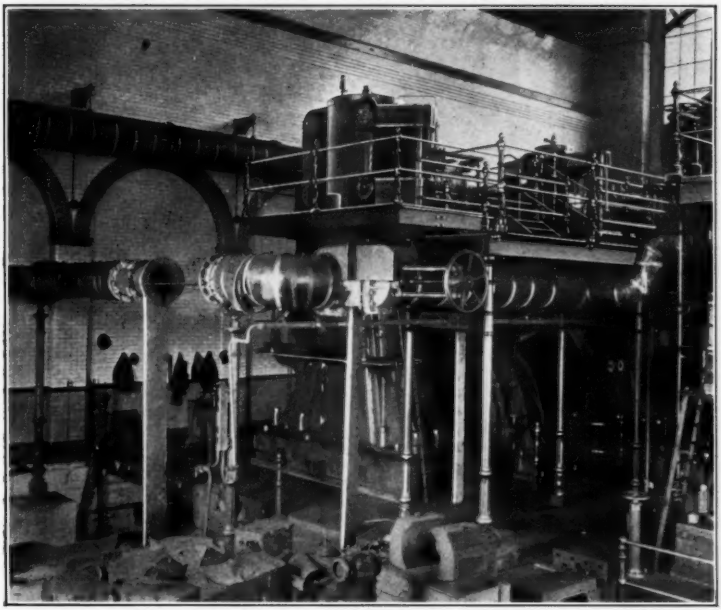
LANCASHIRE BOILERS AND VICARS MECHANICAL STOKERS, HULL CORPORATION TRAMWAYS.



MUSGRAVE ENGINES AT BOLTON CORPORATION ELECTRICITY WORKS.
Cylinders 24 and 45 inches by 42 inches stroke; 100 revolutions per minute.

considered in the case of electric lighting. The load is constantly varying and the variations are large and sudden. Breakdowns are more serious than in a lighting station, so large factors of safety are necessary, and in many cases the station must be in continual operation for several consecutive days. The conditions under which a traction engine works are, if anything, more onerous than those of a rolling-mill engine; a slight variation either in the number of revolutions per minute or in the angular velocity during one revolution is

very serious in a traction-station engine, whereas it is of no consequence in a rolling mill. Constancy of speed is of especial importance where polyphase currents are used, and under no circumstances should the angular velocity during one revolution vary more than three quarters of one per cent., or 1/30 of one natural degree per revolution.

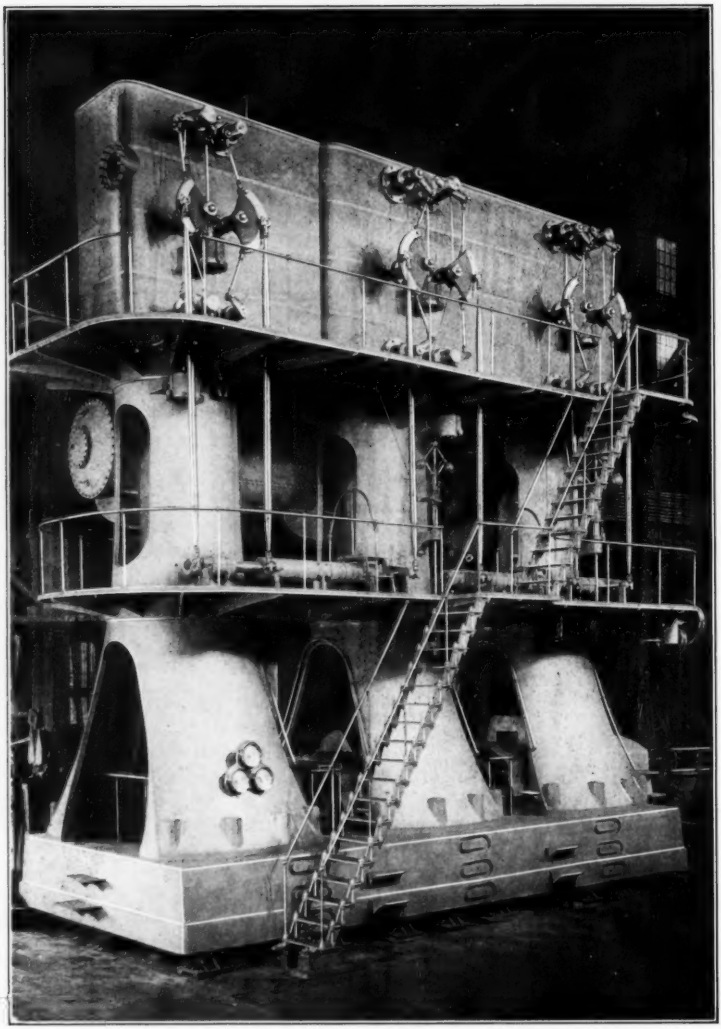


BOLTON CORPORATION ELECTRICITY WORKS. MUSGRAVE ENGINES OF 1,000 HORSE POWER.

Cylinders 24 and 45 inches by 42 inches stroke; 100 revolutions per minute.

It may be of interest to describe briefly one or two stations containing slow-speed engines built by British firms.

Bolton Corporation Electricity Works. Steam is supplied by nine Lancashire boilers through a system of steam piping which consists of two ring mains. The engines, which were supplied by Messrs. Musgrave & Sons, are of the vertical cross-compound condensing type, fitted with Corliss valve gear, and run at 100 revolutions per minute. There are two units, each 1,000 indicated horse power, but capable of giving 1,350 horse power, and two 500-horse-power units, which can work up to 650 horse power. The generators and flywheels are placed between the high- and low-pressure cylinders. The following are some of the dimensions of the 1,000-horse-power engines:—



ALLIS ENGINES FOR THE GLASGOW CORPORATION TRAMWAYS.
As erected in the works before shipment, without the shaft, flywheel, or outboard bearing.

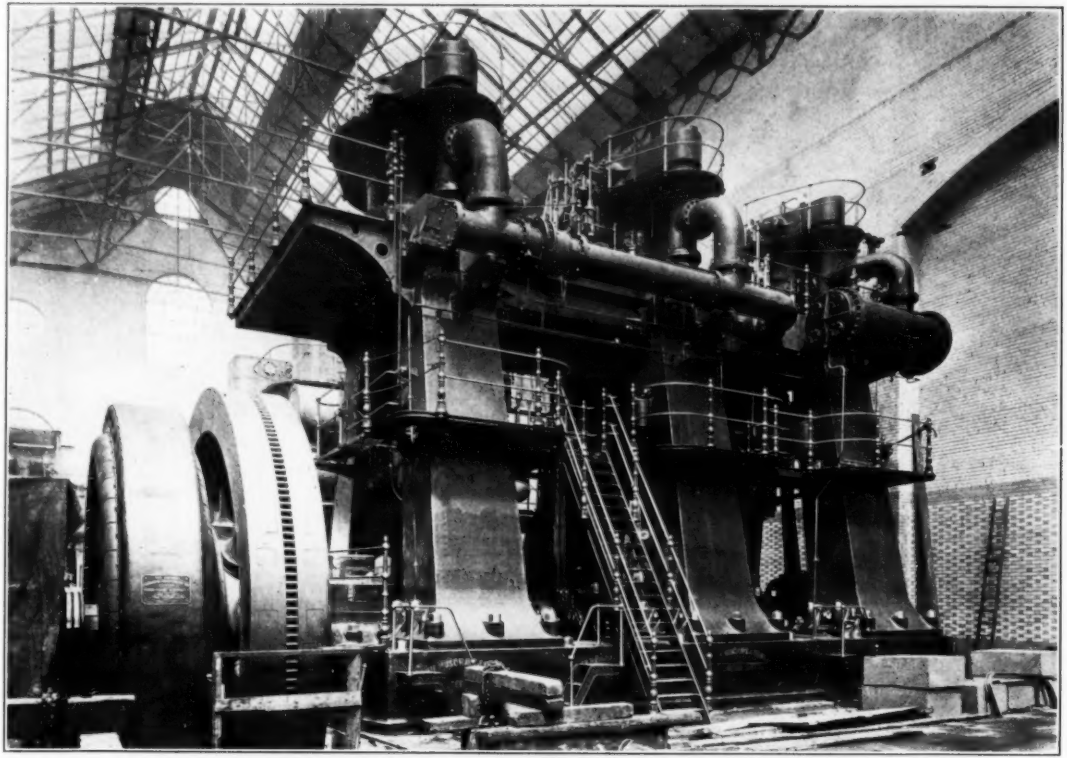
Cylinders, 24 inches and 45 inches, by 42 inches stroke; high-pressure piston rod 5 inches diameter, low-pressure 5¼ inches diameter, connecting rods, made of iron, 8 feet 9 inches long, 5¼ inches diameter at crosshead end and 7½ inches diamter at crank end; crank shaft, made of Siemens steel, 14½ inches diameter and 29 inches long in the neck, 15½ inches diameter in the body, and 19 inches diameter at the wheel boss; flywheel 18 feet diameter and weighs 40 tons of 2,240 pounds, built up of eight rims, segments, and arms, held together by cotters and bolts.

The governor is driven by ropes from the main shaft and acts directly on the Corliss trip gear. The crank chamber is entirely enclosed. Lubrication is effected at a pressure of about 10 pounds by a small pump worked by a link from the exhaust-valve eccentric rod. The engines are guaranteed to maintain constant speed within 2½ per cent. either way from the normal between full load and no load.

Glasgow Corporation Tramways. In the case of the Glasgow Tramways there will be furnished ample data for comparing English and American Corliss engines, built to the same specification. In this instance there are two engines by Musgrave & Sons and two by the Edward P. Allis Company, supplied by Messrs. Robert W. Blackwell & Co., Ltd., of London, both built to Mr. H. F. Parshall's specification; both pairs are of the three-cylinder vertical compound type, each engine indicating 4,000 horse power at normal load, when running at 75 revolutions per minute.

The Allis engines are of the well-known Reynolds-Corliss type, and the following dimensions will give some idea of the size:—

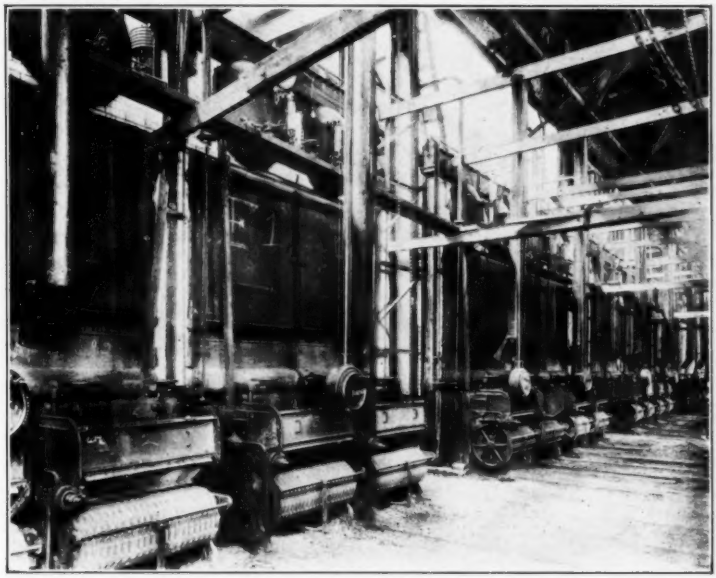
The cylinders measure 42 inches, 62 inches, and 62 inches diameter by 60 inches stroke. The first and second journals measure 22 inches by 36 inches, the third and fourth 24 inches by 36 inches, the fifth 32 inches by 64 inches, and the outer bearing 30 inches by 48 inches. The diameter of the shaft through the fly-wheel and generator is 36 inches. The dimensions of the crank pins are:—High-pressure, 12 inches by 12 inches; first low-pressure, 16 inches by 12 inches; second low-pressure, 20 inches by 12 inches. All three piston rods are the same size, viz., 8 inches diameter. The cylinders are furnished with Reynolds-Corliss automatic double-ported valve gear, each with two eccentrics, the valves being in the cylinder heads. The speed is controlled by a special weighted type governor which acts upon both high-pressure and low-pressure cylinder gears. Attached to each steam-valve wrist-plate there is a disconnecting device, which enables the valve gear of any cylinder to be worked by hand. The ec-



MUSGRAVE ENGINES IN THE POWER PLANT OF THE GLASGOW TRAMWAYS.

Cylinders 42, 60, and 60 inches by 60 inches stroke; 75 revolutions per minute, steam at 140 lb. pressure; normal indicated horse power 4,000, maximum 5,000. British Thomson-Houston three-phase alternator, 2,500 kilowatts, 6,500 volts, 25 cycles.

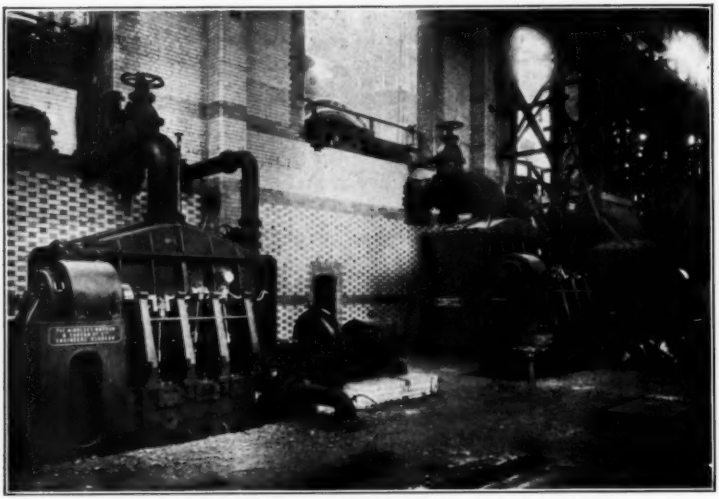
centric straps are lined with babbitt, bored and scraped to fit the sheaves. The eccentric sheaves are secured to the shaft by means of adjustable keys to allow for correct adjustment of position. The rocker-arm pin is so fitted as to be capable of easy removal. The cross-heads are fitted with babbitt-faced removable and adjustable shoes, turned and scraped to fit the bored sides of the vertical frames. The cranks are of the fan-tail pattern and are set at an angle of 120 degrees. The shells of the main journal bearings are of cast iron and are water-jacketted. They are lined with babbitt metal, expanded in



BABCOCK AND WILCOX BOILERS WITH CHAIN-GRATE STOKERS, PINKSTON POWER STATION, GLASGOW.

place and bored and scraped to fit the shaft, with suitable oil channels to effect an even distribution of oil. There is one top and one bottom shell, with a spherical seating; the lower shell can be removed by jacking up the shaft half-an-inch. The steam consumption is guaranteed not to exceed 14 pounds per brake horse power when indicating 4,000 horse power under normal conditions.

The description given above of the Allis engines would, in the main, be equally applicable to the engines made by John Musgrave and Sons, but one or two dimensions are a little different. In this engine, the high-pressure, first low-pressure, and second low-pressure



CONDENSERS AND PUMPS, PINKSTON POWER STATION, GLASGOW.

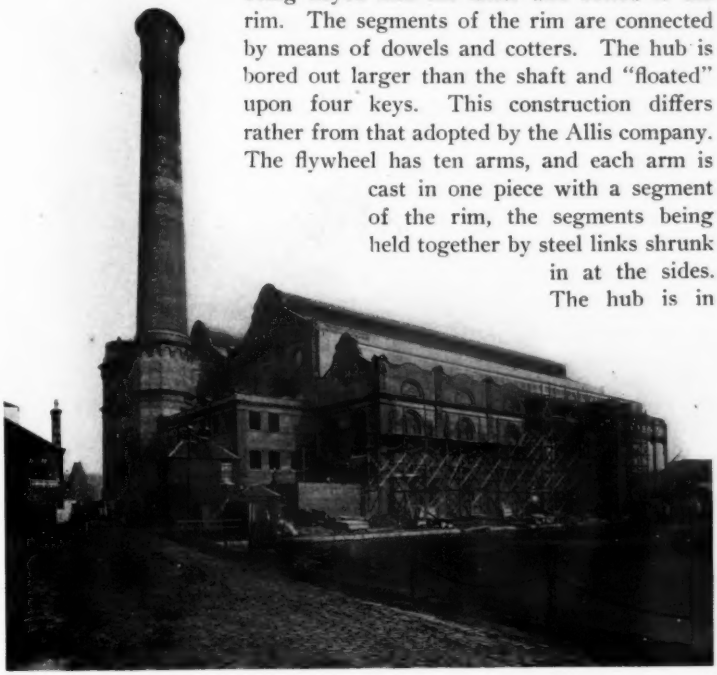
crank pins measure 14 inches by 14 inches, 18 inches by 14 inches, and 22 inches by 14 inches respectively. All the piston rods are 9 inches in diameter; the pistons are of steel with Ramsbottom rings. The valves are of the Corliss cylindrical type, double-ported both for steam and exhaust, and are actuated by the Musgrave roller trip motion. The cross-heads are of cast steel with cast-iron slipper guides and white-metal shoes. The main bearings are also lined with white metal and are fitted with water service throughout.

The crank-shaft and fly-wheel construction in these two engines is totally different. In the case of the American engine, the crank shaft is in three distinct portions, each cylinder practically working its own separate length of shaft. The various portions are not connected together rigidly at the first and second low-pressure crank pins, but these pins are fixed into one only of the crank webs, the other end of the pin having a certain amount of play in the corresponding web. With the Musgrave engines, the crank shaft is in only two parts, united between the first and second low-pressure cranks by a coupling, both low-pressure crank pins being rigidly fixed in both crank webs.

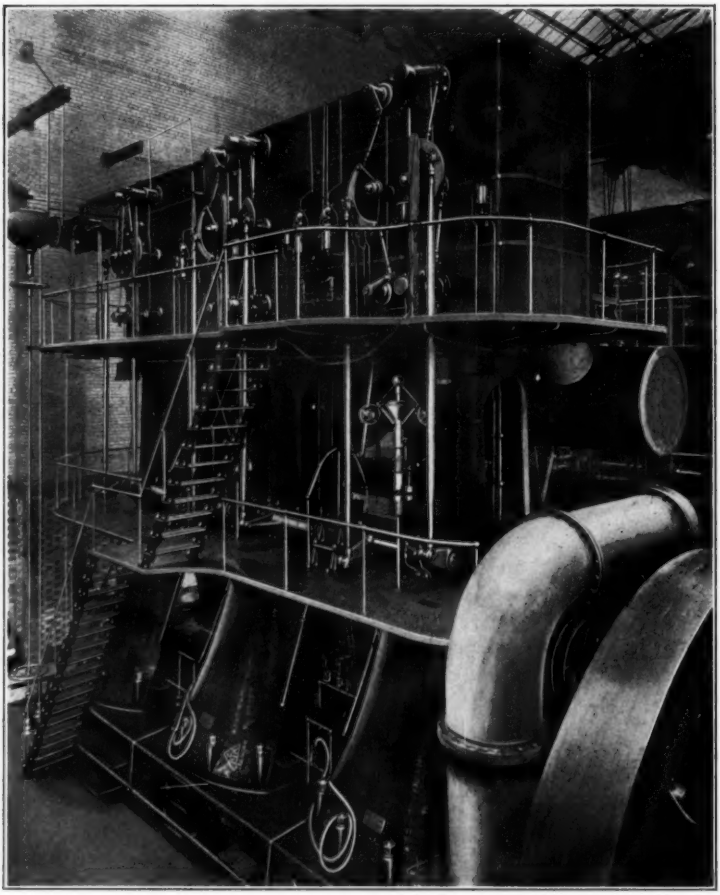
It is noticeable that in the Allis engines, a much greater proportion of the shaft is supported in bearings than is the case with the Musgrave; these bearings are of gun metal lined with white metal for the English engines, and cast iron lined with the same material for the

American. The latter are much closer built altogether and give an idea of greater simplicity than is conveyed by the appearance of the others. In the Allis engine all the cylinders are connected together, and there is no space in between them; the valves are placed at right angles to the line of the crank shaft. The valves on the Musgrave engines are placed parallel to the length of the engine, with the wrist plates and gear in between the cylinders, which are separate from one another. The American slide for the cross-head is bored out concentric with the cylinder to which it is bolted, and is also connected to the frames by bolts. The English makers use a single flat slide which is cast in one with one half of the A-shaped frame; they have also made their bed plate in five pieces, as against the Americans' four, but the method of connecting the parts together is similar.

The flywheel of the Musgrave engine is built up in segments; the arms are separate from the rim and the hub, being keyed into the latter and bolted to the rim. The segments of the rim are connected by means of dowels and cotters. The hub is bored out larger than the shaft and "floated" upon four keys. This construction differs rather from that adopted by the Allis company. The flywheel has ten arms, and each arm is cast in one piece with a segment of the rim, the segments being held together by steel links shrunk in at the sides. The hub is in



PINKSTON POWER STATION, GLASGOW CORPORATION TRAMWAYS.



GLASGOW CORPORATION TRAMWAYS. MAIN ENGINES.

Two Allis engines, three-cylinder-compound vertical, three cranks at 120°, cylinders 42, 62, and 62 by 60 inches, 4,000 horse power at 75 revolutions per minute.

two pieces, and the arms are let in and fastened by bolts arranged parallel to the shaft; the hub is forced on to the shaft by hydraulic pressure, and further secured by two keys. Another point of difference is that the governors of the Musgrave engine are situated on the bed plate, whilst the Allis governors are up by the cylinders, and so can work direct upon the valve gear.

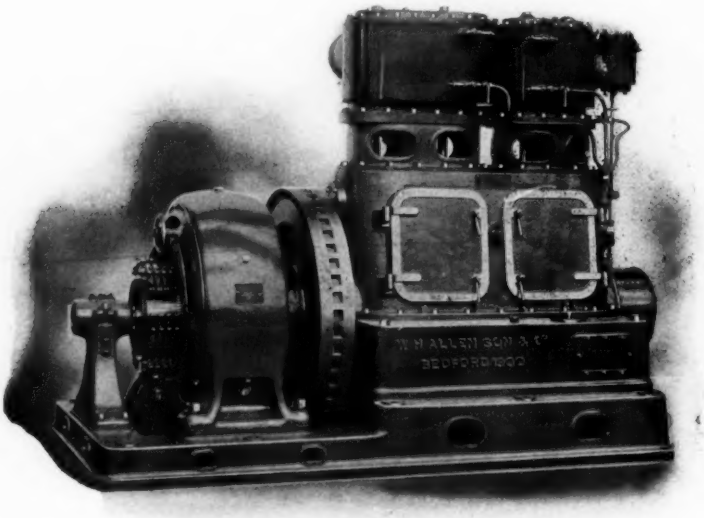
AUXILIARY ENGINES, PINKSTON POWER STATION, GLASGOW.

Duncan Stewart & Co.'s vertical cross-compound Corliss type, cylinders 22 and 44 inches by 42 inches stroke, 90 revolutions per minute, 800 horse power.

It is interesting to note that the British engine as made weighs nearly 100 tons more than was originally estimated, which makes it 50 tons heavier than the Allis engine.

The auxiliary engines at Glasgow were supplied by Duncan Stewart & Company. They are vertical cross-compounded Corliss engines, and in size and design bear a very strong resemblance to the Allis en-

gines which were recently installed for operating the Dublin electric trams. The following are a few details. The cylinders measure 22 inches and 44 inches in diameter by 42 inches stroke. The speed is 90 revolutions per minute. Both piston rods are 5½ inches in diameter; the crank pins measure 6½ inches by 7 inches, and the two main bearings are 18 inches in diameter by 36 inches long. The diameter

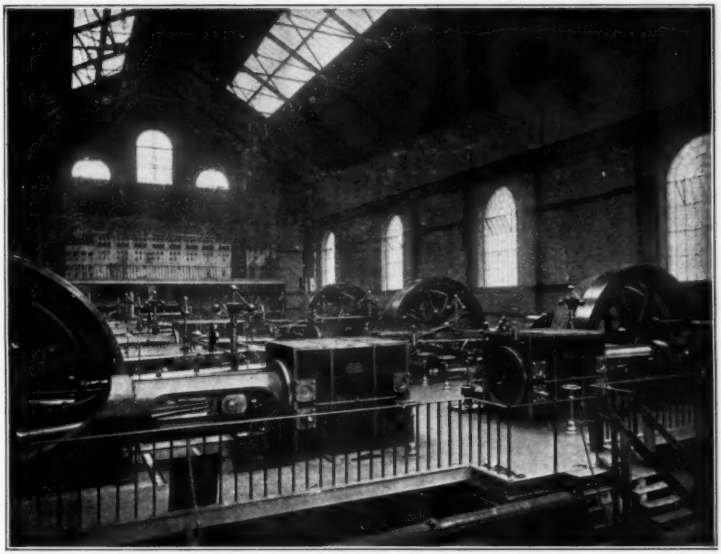


EXCITER ENGINE AND DYNAMO, PINKSTON.

W. H. Allen Sons & Co. high-speed enclosed vertical-compound two-crank engine, cylinders 11 and 19 inches by 8 inches stroke, 100 indicated horse power at 300 revolutions per minute.

of the crank shaft under the flywheel and armature is 20 inches. The flywheel is 19 feet in diameter and weighs about 34 tons, two-thirds of which is in the rim. The rim is in ten segments, each segment being cast with one arm. The hub consists of two flat discs, to which the arms are bolted, and the segments of the rim are held together by mild-steel dowel plates and cotters. The governors are of the high-speed Porter type; one regulates the speed whilst the other acts as a safety stop. The valve gear is of the Reynolds-Corliss type fitted with wrist-plate motion, and the trip gear is controlled by the governors. The engines have a normal working load of 800 horse power, and each is direct-coupled to a 500-kilowatt generator.

In addition to the slow-speed engines already described, the power station at Glasgow contains six high-speed engines of British manufacture which run the dynamos for exciting the main generators. These engines were built by Messrs. W. H. Allen, Son & Co., of Bedford, and are of the enclosed high-speed compound type, with two cranks at 180 degrees. Each develops 100 indicated horse power when running at 300 revolutions per minute with a boiler pressure of 150 pounds per square inch. The cylinders, two in number, measure 11 inches and 19 inches in diameter by 8 inches stroke; the cylinders are cast separately and each is provided with one piston valve; they are mounted upon a cast-iron trunk which is provided with two hinged doors in the front. All the working parts are made of mild Siemens-



POWER STATION OF THE CENTRAL LONDON RAILWAY.

Six Allis engines, horizontal cross-compound condensing, cylinders 23 and 46 inches by 48 inches, 94 revolutions per minute, 850 kilowatts.

Martin steel. The eccentric sheaves are forged solid with the shaft and have straps of cast steel. The crank shaft is 4½ inches diameter. The main bearings and big ends are all lined with white metal, the shells of the bottom halves of the main bearings being made of cast iron, with steel caps. Forced lubrication is supplied by means of a special valveless oil pump worked from one of the eccentrics under

an average pressure of 25 pounds per square inch. The stationary field of the dynamo is mounted upon a continuation of the engine bed.

During the last few years, owing to the conservatism of English manufacturers, a large number of American engines have been imported into Great Britain. The following list gives some data of the most important of such imports. British manufacturers are, however, I am glad to say, waking up and at the present moment their deliveries are equal to, if not better than, those of American engine builders and their prices are from 15 to 25 per cent. lower, which is to say the least encouraging for Great Britain. What with trusts and the indifference to consumers' wants engendered thereby, and to the self-satisfaction and growing carelessness of American exporters, the British home producers may hope for better times.

The following table gives some data concerning American engines which have been put in, in Britain.

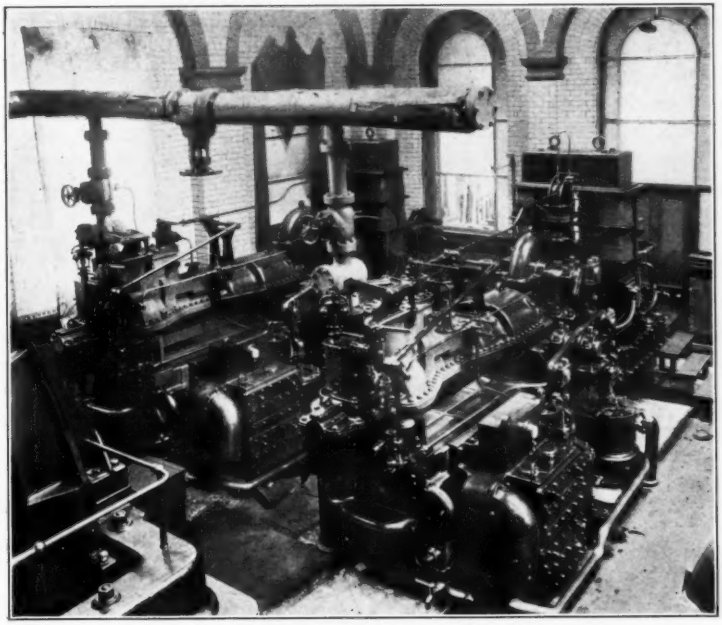
Name.	Type.	Number Supplied.	Size.	Revs. per Min.	Power in K.W.
Central London Railway.....	H. C. C. C.	6	$\frac{23 \& 46}{48}$	94	850
City Road Lighting Station...	"	2	$\frac{19 \& 38}{42}$	100	525
Middlesboro Tramway.....	"	3	$\frac{16 \& 32}{36}$	100	300
Ellesmere Port Smelting Plant.	"	2	$\frac{19 \& 38}{42}$	100	450
Bristol Tramways.....	V. C. C. C.	4	$\frac{22 \& 44}{42}$	90	625
Dublin Tramways.....	"	6	$\frac{20 \& 40}{42}$	90	500
Bankside Lighting Station...	"	3	$\frac{28 \& 60}{48}$	90	1000
London United Tramways....	"	4	$\frac{22 \& 44}{42}$	90	625
Cork Tramways	H. T. C. C.	2	$\frac{15 \& 30}{30}$	135	300
Isle of Thanet Tramways. ..	"	2	$\frac{14 \& 28}{30}$	135	200
Sheffield Tramways	"	3	$\frac{12 \& 22}{30}$	135	200
Glasgow Tramways	3Cyl. V.C.C	2	$\frac{42 \& 62 \& 62}{60}$	75	2500

H. C. C. C.—Horizontal Cross-Compound Condensing.
V. C. C. C.—Vertical Cross-Compound Condensing.
H. T. C. C.—Horizontal Tandem-Compound Condensing.

A few words of description of some of the recent plants for which the well-known British firm of engineers and contractors,

Messrs. R. W. Blackwell & Co., Ltd., have supplied and erected power-plant material, will be of interest.

Central London Railway. The boiler house occupies a ground space of 148 feet by 87 feet. The upper portion is occupied by steel coal bunkers which have a capacity of 1,500 tons of coal. The bunkers are filled by means of an electrically driven Hunt coal conveyor, of the endless-chain type; the same conveyor is used to remove the ashes.

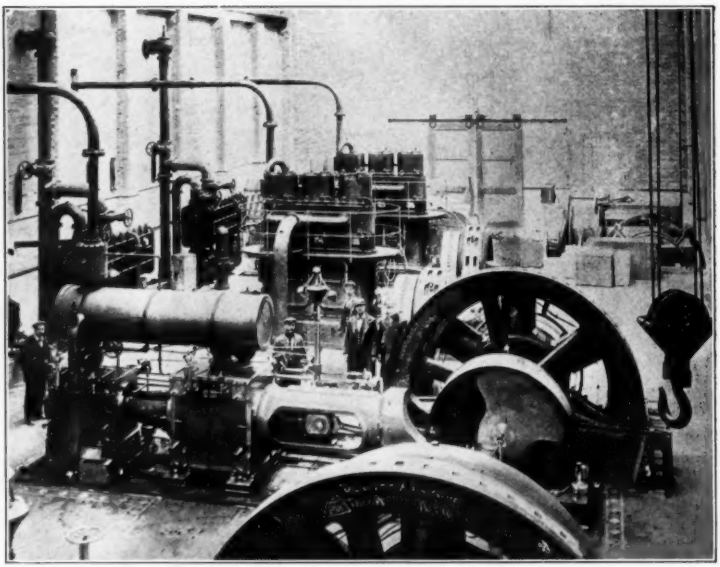


PARSONS TURBO-GENERATORS AT HALIFAX.

The coal feeds into the stokers by means of chutes. The steam-generating plant consists of 16 Babcock & Wilcox water-tube boilers arranged in pairs, with sufficient space left for four additional boilers. Each boiler has a heating surface of 3,580 square feet and supplies steam at 160 pounds per square inch pressure. The gases from the boilers go through four Green's economisers on their way to the smoke stacks. These last, which are made of brick work, are 200 feet high, with an internal diameter at the base of 10 feet. The boilers are stoked by Vicars mechanical stokers.

The engine room is 200 feet long by 86 feet wide, and contains six engines made by Edward P. Allis Co., of Milwaukee. These engines

are of the horizontal cross-compound condensing type, with the generator mounted on the shaft between the two cylinders. The cylinders measure 23 inches and 46 inches diameter by 48 inches stroke, and each unit yields 850 kilowatts at normal load when running at 94 revolutions per minute, with 150 pounds per square inch steam pressure. The valve gear is of the usual Reynolds-Corliss type, with two eccentrics for each cylinder. There is a multitubular reheater receiver between the high- and low-pressure cylinders. The crank shaft, which is made of fagotted iron, is 22 inches diameter in the centre where the flywheel and generator are located, and 20 inches diameter in the bearings. The bearings are 36 inches long, the shells being lined with Babbitt metal. The flywheel is 18 feet in diameter, made



ISLE OF THANET RAILWAYS POWER STATION.

Two Bellis engines of 260-325 indicated horse power, 300 revolutions per minute, and two Allis engines, horizontal tandem-compound condensing, cylinders 14 and 28 inches by 30 inches, 135 revolutions per minute, maximum continuous indicated horse power 480.

in eight segments, and weighs about 100,000 pounds. The segments of the rim are held together by wrought-iron arrow-headed links shrunk in at the sides. The cross-head pins are 7 inches diameter by 7 inches long, and the crank pins are 8 inches diameter and 7 inches long, forced into the cranks and rivetted over. The connecting rods are made of forged steel and measure 12 feet between the centres.

The high-pressure and low-pressure piston rods measure 3⅞ inches and 4⅞ inches in diameter respectively. The cross-head is made of cast iron, with babbitt-faced removable and adjustable shoes, turned and scraped to fit the bored slides.

The steam from the engines is condensed in six Allis jet condensers combined with the air pumps; each condenser has a capacity of 26,000 pounds of steam per hour. The condensed and injection water is cooled in four Barnard cooling towers, each tower being furnished with a pair of fans running at 180 revolutions per minute, which are driven by a Bellis engine. These towers are 50 feet high and have a diameter of 14 feet 8½ inches.

The Dublin United Tramways power station at Ringsend is also equipped with six Allis engines at 800 horse power each. These are of the vertical cross-compound condensing type, but otherwise do not differ in principle from those of the Central London Railway. The sizes of the cylinders are 20 inches and 40 inches by 42 inches stroke.

Isle of Thanet Light Railways. The boiler house and engine room are side-by-side and of equal size (134 feet by 50 feet). There is also a coal store 20 feet wide which runs the whole length of the building. In the boiler house there are four Babcock & Willcox boilers, arranged in two batteries, which supply steam at 160 pounds. Each boiler has a heating surface of 3,140 square feet; the steam drums measure 42 inches in diameter and are 7 feet long, and the boiler tubes are 18 feet long and 4 inches diameter. The feed water is heated in an economiser made by the Claycross Company. The boilers are hand-fired. The steam piping is lap-welded mild steel, the flanges being screwed on. The lay out of the piping is on the single-header system A duplicate system of feed piping is installed.

In the engine room there are two slow-speed Corliss engines built by the Edward P. Allis Company and two high-speed Bellis engines. The former are of the horizontal tandem-compound type, running at 135 revolutions per minute, with 150 pounds steam pressure. The cylinders measure 14 inches and 28 inches diameter by 30 inches stroke. Each engine has mounted upon its shaft a 200-kilowatt continuous-current generator, and is capable of developing continuously a maximum power of 480 indicated horse power. The crank shaft is made of iron hammered from selected scrap, and is 15 inches diameter at the flywheel and generator, and 13 inches diameter in the main bearing. This last is of cast iron lined with Babbitt metal, and is 19 inches long. There is also an outboard bearing of the same length. The flywheel is 12 feet in diameter and weighs 22,000 pounds.

The crank pins are made of forged steel, 5½ inches diameter and 5½ inches long, forced into the cranks and riveted over. The cross-head pins measure 5 inches by 5 inches. The connecting rod is of steel with solid ends having wedge adjustments. The cross-head slide is bored concentric with the cylinders.

The high-speed engines are of the usual three-crank vertical-compound condensing enclosed type, made by Messrs. Bellis & Morcom. Each engine is capable of developing 260 to 325 indicated horse power with a steam pressure of 150 pounds and running at 300 revolutions per minute, and is direct-coupled to a 300-kilowatt three-phase dynamo.

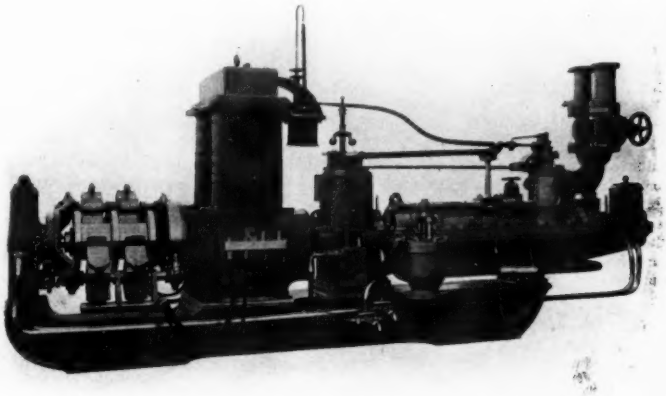
The steam from the engines is condensed in three Wheeler surface condensers, with combined steam-driven air and circulating pumps, mounted underneath the condenser and on the same bed plate. The circulating water is cooled by means of cooling towers supplied by the same makers as the condensers.

I cannot complete the description of British steam-engine practice without a few words concerning the most remarkable steam engine of the present day, viz., the Parsons steam turbine, which has been remarkably successful and which may yet be destined to revolutionise steam-engine building on land and on sea.

The Parsons steam turbine in mechanical design is a radial-flow turbine. In construction it consists essentially of a drum revolving inside a cylindrical case, the axis of drum and case being the same. Upon the drum are mounted a series of blades arranged in rings round the drum, a certain amount of space being left between the rings. Corresponding blades are fitted in the interior of the case, being so placed that they fill up the spaces left between the blades on the drum. The tips of the blades on the drum just clear the inside of the case, and the tips of the blades mounted inside the case just clear the surface of the drum. The former are the moving blades, and the latter the fixed or guide blades. The turbine is governed by admitting the steam in a series of gusts by means of the periodic opening and closing of a double-beat valve. When the turbine is used to run a dynamo, an electric governor is employed, the duration of each gust being controlled by an electric solenoid, which is connected as a shunt to the field magnets. The action of this governor is so satisfactory that if the whole of the load is suddenly thrown off, the variation in speed is not more than 2 per cent.

The advantages claimed for the turbine are many. The space required to instal it is small, the first cost is low, and the upkeep and at-

tendance are small. Owing to the absence of vibration, no costly foundations are necessary; there is no cylinder lubrication, and consequently the exhaust steam is entirely free from oil.



PARSONS STEAM TURBINE AT THE HOTEL CECIL, LONDON.
Direct connected to 75-kilowatt generator at 110 volts.

The following figures show some of the results obtained with a 200-unit turbo-dynamo.

TESTS OF 200-UNIT TURBO-DYNAMO.

Kilowatts.	Total water per hour. Lbs.	Water per kilowatt. Lbs. per hour.	Water per E. H. P. Lbs. per hour.	
219·2	9,466	43·20	32·22	Non-condensing.
98·7	5,848	59·23	44·18	
54·5	4.330	79·50	59·30	
0	2,092	.....	....	
203·0	8,429	41·52	30·97	Non-condensing and superheating 30 degs. Fahr.
106·1	5,287	49·83	37·17	
0	1,402	.....	.....	
208·0	5,443	26·16	19·51	Condensing but no superheating. Vacuum at full load 25 in.
108·4	3,037	28·02	20 90	
0	531	....	.....	

The difficulty in constructing turbo sets has been with the electrical portion. The high speed renders the construction of the armature and commutator in a continuous-current machine a very difficult problem. Turbines of 5,000 horse power are now being built and the tests show that for units of that size the economy as regards steam consumption is as high as with the best slow-speed engines.

My next paper will consider Continental practice and its salient characteristics.

THE DEVELOPMENT OF THE PETROLEUM AUTOMOBILE.

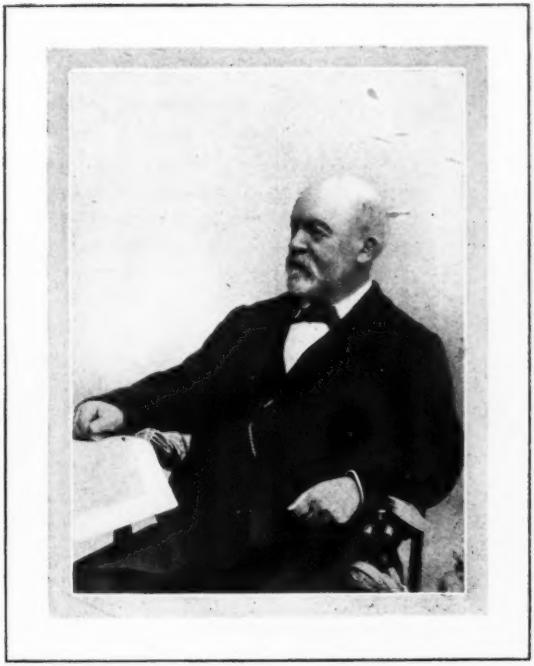
By Paul Daimler.

The fundamental work of the late Gottlieb Daimler in the development of the petroleum automobile is generally recognised in engineering circles, and it was the intention of the editors to have the story of his life work told by himself in these pages, the engagement having been made only a short time before his death. The present paper has been prepared from material left by him, and has had the careful revision of his son and successor, and hence is an altogether authoritative and representative account of the contribution of the "father of the automobile" to what has become such an important technical and commercial industry.—THE EDITORS.

MONG the various problems connected with the subject of mechanical locomotion in streets and on highways, the question of the motive power is admittedly the most important. Practically the motors for this service may be divided into three classes:—electric motors, using current from storage batteries; steam-driven motors, involving the carrying of some form of boiler; and internal-combustion motors, using benzine, gasoline, or petroleum as fuel. Electricity is limited to conditions where charging of batteries is practicable and where distances are moderate; steam has shown itself to be best adapted for slow speeds and heavy loads; while for general purposes, for all kinds of passenger automobiles and motor cycles, the internal-combustion motor has met with the greatest favour and success.

The development of this type of motor is historically bound up in the career of the late Gottlieb Daimler, so that he has been called "the father of the automobile," and a review of the work done by him will show the extent to which it has influenced modern automobile construction.

The internal-combustion motor, of which doubtless the best-known general form is the Otto gas engine, generally operates on the so-called "four-stroke" cycle. On the first outward stroke of the single-acting piston, the mixed charge of air and gas is drawn in; on the next inward stroke the charge is compressed; the compressed charge is then ignited, producing the outward power stroke; and the next inward stroke is the exhaust, clearing the cylinder of all products



GOTTLIEB DAIMLER.
"The Father of the Automobile."

Born at Schorndorf, Württemberg, 1834; died at Cannstadt, near Stuttgart, 1899.

of combustion. While this cycle gives a high degree of economy, it will be seen that such an engine must be larger and heavier than a steam engine which, to develop the same power, makes four times as many power-strokes in the same time. This fact at first rendered the internal-combustion engine altogether unsuitable for use as a motive-power for mechanically propelled vehicles, and it was originally employed for stationary purposes only.

Gottlieb Daimler, after receiving a technical and scientific education at the Polytechnic School at Stuttgart, and a practical training in the Karlsruhe Machine Works, entered the newly founded Gas Engine Works at Deutz in 1872, and under his skilful direction this establishment, better known as the Otto Engine Works, grew in ten years from a small shop into a large, well-organised, and famous works. During his experience in this connection Herr Daimler gave careful study to

THE ORIGINAL DAIMLER MOTOR-CYCLE.

This vehicle, built and operated in 1885, is probably the first actual operative internal-combustion automobile in use, and was the forerunner of the modern motorcycle.

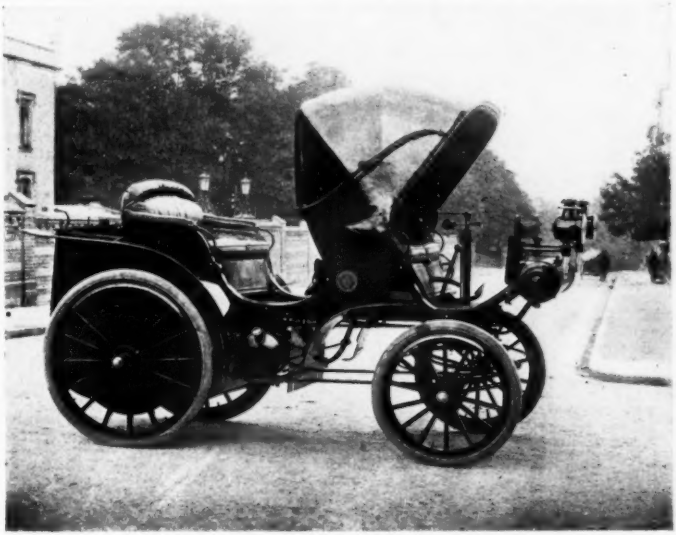
the improvement of the internal-combustion motor, and soon realised that if its relative size and weight were to be materially reduced the running speed must be greatly increased, this being the most obvious method of increasing the power without increasing the weight. The original Otto engine was provided with what was called the "flame ignition"—that is, the compressed charge in the cylinder was put into brief connection with a burning gas jet by means of a moving slide, the flame being blown out by the explosion and relighted from a fixed gas jet. This method of ignition limited the speed of the engine to a comparatively low number of revolutions, and it was this defect which Daimler sought to remedy.

Instead of using the uncertain-acting flame with its inconvenient speed limitations, Daimler invented and introduced in 1883 the so-called "hot-tube" ignition. This consisted of a metal or porcelain tube attached to the compression space of the cylinder, in such a manner that the interior of the tube was

THE FIRST DAIMLER MOTOR CARRIAGE.

The motor was connected to the driving axle by two belts, one for high speed and the other for hill climbing, either one being thrown into action by a tightener. Both could be thrown out of action to stop the carriage without stopping the motor. This vehicle was in successful operation in 1885.

in continual communication with the compression space. A gas flame, continually burning under the tube, maintained it at a glowing red heat, so that the mixed charge of air and gas, when compressed into the tube, became fully and effectively ignited. Experience showed that by a proper regulation of the temperature of the hot tube the ignition could be made to take place at any desired point in the compression, and thus the complicated, slow and uncertain slide flame ignition was replaced by a simple device, without moving parts, altogether satisfactory and reliable. The

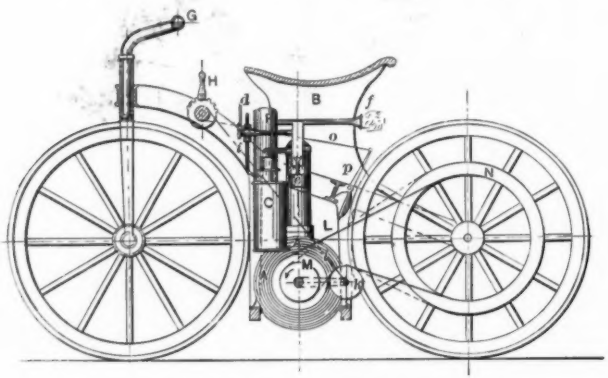


DAIMLER VICTORIA.

For city and park driving and general private use.

especial feature of the hot-tube ignition, however, was soon found to be the increased speed which it permitted. By its use the rotative speed could be increased eight to ten times over the older motor, and hence the weight could be reduced in nearly the same proportion. This fact at once showed Daimler that the application of the internal-combustion motor to mechanically propelled vehicles had become a possibility, and that, with the use of hydro-carbon vapour as fuel, and the high-speed hot-tube motor, the petroleum automobile might become a practical possibility. He therefore severed his connection with the Otto Engine Works at Deutz and, returning to Cannstadt, near Stuttgart, his early home, he devoted his entire time and atten-

tion to the design of a light petroleum motor and motor vehicle. The result was the production, in 1885, of a motor-bicycle, shown on this page, of which the general construction is apparent upon inspection. The motor A was placed directly under the seat B, between the legs of the rider. The petroleum was drawn from the tank b, the supply being regulated by the valve d. The motor was first set in motion by lighting the lamp e and turning the crank a few times, the discharge passing through the chamber F and exhaust-pipe f. After the motor had been fully started, the vehicle was set in motion by moving the lever H, which drew the tightening pulley k against the belt L, and so caused the power to be transmitted from the pulley M to N. Changes of speed were attained by using pulleys of different sizes, similar to the cone pulleys on a lathe. This machine was put into successful action at Cannstadt on November 10, 1885, and is believed to be the first petroleum-driven automobile in practical use.



THE FIRST DAIMLER MOTOR-CYCLE.

Showing the position of the cylinder between the legs of the rider, and the arrangement of belt driving for starting and stopping.

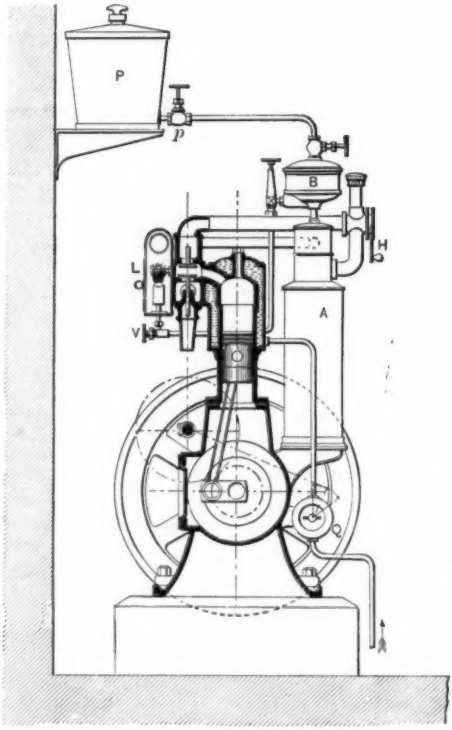
The general arrangement of the motor itself is shown on the next page, which shows a section of the single-cylinder motor as arranged for stationary use. The simplicity of the machine is most apparent; there are but two valves, the inlet and the exhaust, and the ignition is effected by the compression of the charge into immediate contact with the tube L, kept hot by the external flame. When benzine is used as fuel the air is carburetted by contact, but when the petroleum is employed it is necessary to use a vapouriser. The carburetter is shown on page 363. The reservoir for benzine holds about 18 litres, the fuel

HEAVY VIS-A-VIS CARRIAGE.

This type of Daimler touring carriage has been successfully used by the *Oesterreichischen Touring-Klub* for mountain touring in the Tyrol.

DAIMLER MOTOR BOAT.

The first Daimler motor boat was built in 1886; the length was six metres, and with a two horse-power motor and a load of twelve persons it was propelled at a speed of 10 kilometers per hour without difficulty.



DAIMLER STATIONARY MOTOR.

Giving an excellent idea of the simplicity of the machine, and the fewness of operative parts. The motor for vehicles is similar in construction.

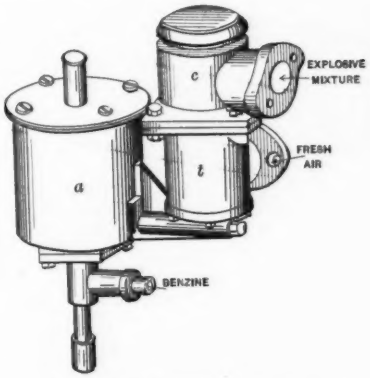
being delivered to the carburetter by a pipe d, all impurities being caught by a sieve f. The flow is regulated by a float g, acting upon a pin-valve, a constant level being thus maintained. The benzine then passes through the pipe u and nozzle K, and with every suction stroke of the engine it is sprayed into vapour by the in-drawn air, the cone l serving to disperse the mixture, and the proportions of air and vapour being controlled by regulating the air-admission openings. The external appearance of the carburetter is shown by the upper figure on page 363.

The general appearance of the single-cylinder motor as arranged for stationary use is given on page 364, from which it will be seen that very great simplicity has been secured. A still better form is shown on page 365, which has two cylinders inclined slightly to each other, and gives proportionately greater power for its weight. This especial form is that used for small boats and launches, but the principle and general construction are the same for motor vehicles.

An interesting feature in connection with the Daimler motor is the arrangement of the cooling-water circulation for the cylinder jacket. The water is contained in a tank, from which it is circulated in the cylinder-jacket by means of a small rotary pump. From the jacket it passes to the cooler. This consists of a system of several hundred small tubes over which a blast of air is driven by a fan operated from

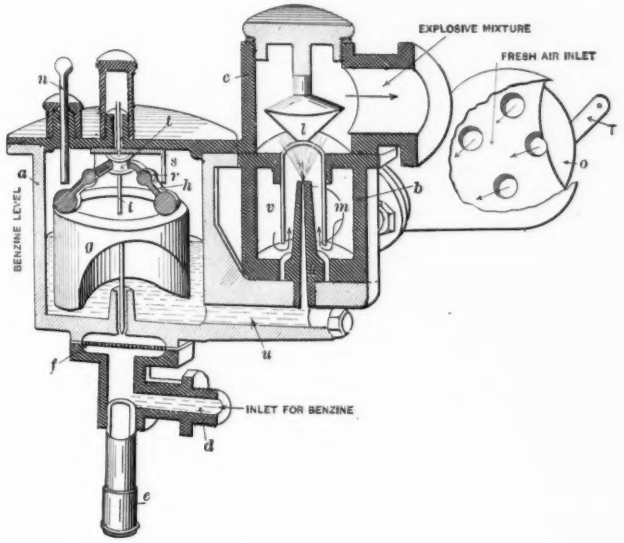
the motor shaft. Since the speed of the fan increases with the speed of the motor, the cooling is proportional to the production of heat in the cylinder.

In addition to gas, which is applicable for stationary motors only, the fuel may be benzine of a specific gravity of 0.68 to 0.70, or ordinary lamp petroleum. The consumption varies according to the size of the motor, ranging from 0.36 to 0.45 kilogrammes per horse-power hour for vehicles, or somewhat less for boats. A variety of vehicles are shown in the accom-



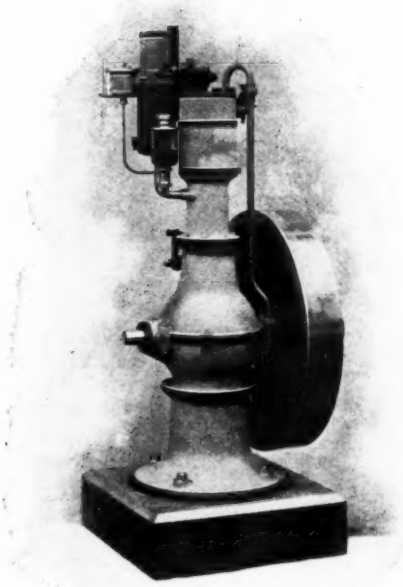
EXTERIOR OF DAIMLER CARBURETTER.

Showing the entrances for air and fuel and exit for explosive mixture, as well as the general construction of the apparatus.



THE DAIMLER CARBURETTER.

The hydrocarbon fuel is drawn in by air suction and mingled with air against the cone, the explosive mixture being delivered to the cylinders ready for use as a gas.



SINGLE-CYLINDER DAIMLER MOTOR.

This is the motor as arranged for stationary service. The principle is the same for motor vehicles, with the absence of the fly-wheel and the introduction of the proper attachment to the frame.

panying illustrations, the arrangement varying according to the service required.

In this general review of the development of the internal-combustion motor as adapted to automobile vehicles by Daimler, it is interesting to note the various stages in the history of the subject.

The application of mechanical power to vehicles for common roads had been attempted early in the nineteenth century, and at intervals thereafter, and while such machines as heavy traction engines using steam power found a limited application, the question of weight prevented the employment of self-propelled vehicles for general purposes. Sporadic attempts were made at the construction of motors adapted for vehicle propulsion, but until the work of Daimler, such machines were but the isolated attempts of their projectors and not efforts to produce commercial automobile vehicles for general use.

The first grasp of the fundamental condition of success lay in the realisation of the fact that the weight and size of the motor must be reduced by running it at a high speed, but this idea was of no practical use until it was followed up by the invention of a means for enabling the internal-combustion motor to be transformed from the slow, heavy machine of 1882 into the small, light, rapid motor of to-day.

Since the establishment of this fundamental principle the gasoline motor-vehicle has held its place against all rivals, and it is a

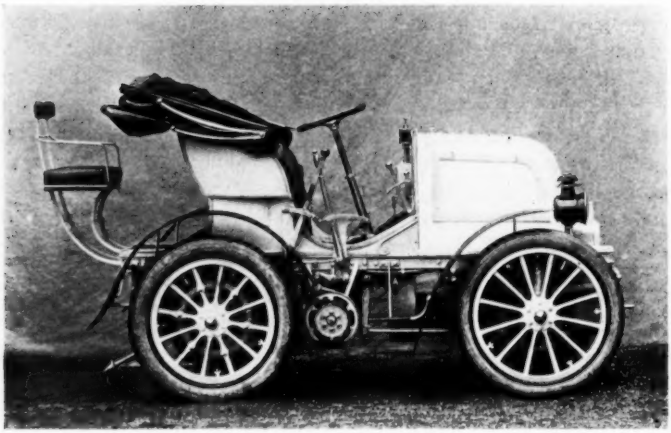
matter of general knowledge that in all the long-distance and high-speed trials the vehicles equipped with internal-combustion motors, using benzine, gasoline, or spirit, have surpassed those using motors of other types.

Light motor vehicles using steam as a motive power have succeeded just so far as they have approached the internal-combustion motor in general construction and operation, small high-speed engines, using steam of such high pressure as almost to approach steam-gas, being the most successful; but the presence of the boiler adds weight almost sufficient to make up for the superior advantage of the greater number of power strokes per revolution. Some of the most effective steam engines are most closely modelled after the gasoline motors, being single-acting, with poppet valves operated by cam and spring motion in a manner altogether similar. Up to the present time, however, the internal-combustion motor has maintained its lead for motor-vehicle purposes, and there is every prospect that it will continue to hold its position by reason of its inherent advantages, just as it is rapidly advancing in stationary service.

In this connection it is interesting to observe that it is the development of the light-weight, high-speed, internal-combustion motor which has made the dirigible balloon a practical possibility, furnishing a motive power sufficiently light in weight to permit the driving of propellers sufficiently large to enable the necessarily large air resistance of the gas bag to be overcome, and it is possible the motor may yet be so lightened as to make a self-lifting machine possible.

DOUBLE-CYLINDER DAIMLER MOTOR.

By the use of two cylinders the number of impulses per revolution, and consequently the power, is doubled, without a proportional increase in weight.



DAIMLER MOTOR CARRIAGE.

A convenient form of automobile for city and general use.

DAIMLER MOTOR TRUCK.

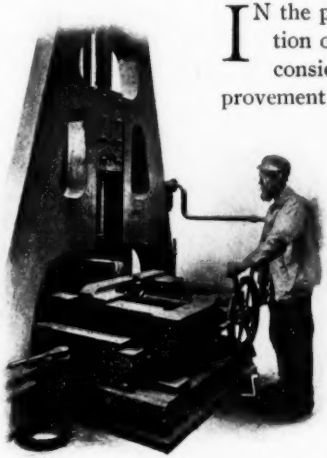
Many of these are in use for hauling heavy merchandise, brewery service, etc. The one illustrated has a capacity of six metric tons.

THE PROPER DISTRIBUTION OF ESTABLISHMENT CHARGES.

By A. Hamilton Church.

VI. THE APPORTIONMENT OF OFFICE AND SELLING EXPENSE.

With this paper Mr. Church draws to a close a new and most valuable contribution to the applied science of cost keeping. The series of articles, which began in THE ENGINEERING MAGAZINE for July last, has included the following topical headings: The Interlocking of General Expense with Piece Costs; Various Methods of Apportioning Expense to Work; The Scientific Machine Rate and the Supplementary Rate; Classification and Dissection of General Shop Expense; Factory and Mass Production and the New Machine Rate; and (in this number) The Apportionment of Office and Selling Expenses. The whole discussion forms, to quote a fully informed critic, "the most thorough analysis of the theory and practice of machine-shop cost keeping yet attempted." THE ENGINEERING MAGAZINE has now under engagement, and will soon have ready for definite announcement, another most interesting study addressed to the interior of the shop, rather than the office—a study of the handling and tracing of large quantities of stock through the machine departments of the factory.—THE EDITORS.



IN the preceding articles of this series the question of shop or works charges has alone been considered. It has been shown that an improvement on the present practice of averaging these charges is possible, and that there is no reason why each item of product shall not be as definitely connected with its proper portion of such charges as with the corresponding portion of wages spent directly on it.

It was explained in the first article that shop charges do not by any means exhaust the whole of the expense account. In addition to the charges actually incurred in production, there is a large section of expenses incurred in advertising, warehousing, packing, transporting, and conducting the commercial processes incident to selling the finished product. These expenses should not on any account be mingled with those due to production.

In the case of a concern of which the works is in the country and the commercial office in the metropolis, this division of charges takes

place naturally and almost automatically. We need not stop to discuss here the few minor points in which the division is indistinct; it will be sufficient to notice that there is for the most part a broad and strongly marked natural distinction between the two classes.

It has already been shown that the shop charges have a real relation to the work, and that all we have to do in their case is not to cover up or average away such real relation, but rather to seek to develop it. We have now to consider whether there is any similar real connection between the value of finished product and the general establishment charges.

It may be stated at the outset that there is no such connection. The cost of marketing an article has no ascertainable relation to the cost of making it. The immediate inference from this is that in whatever way we finally decide to distribute general establishment charges, a more or less arbitrary basis of incidence must be made use of. But this does not imply that there is no utility in discussing this basis very fully. On the contrary, the cost of selling requires as careful elaboration as the cost of producing, inasmuch as commercial ability is more rare and subtle than technical ability, and articles which are being produced cheaply enough may fail to show a profit owing to waste in the methods of finding a market for them.

The modern tendency to eliminate the middleman and sell direct from the factory to the consumer makes the question of general establishment charges one of growing importance. In some trades, as for instance the textile trades, where the product is sold to merchants mostly before manufacture, orders being taken in open market, ("on change"), the general charges bear a very small ratio to the finished article. But in proportion as the commercial side is developed and stocks are held, together with a great extension of advertising, travellers, and agents, these charges begin to loom large and may represent more than half of the ultimate sale price. The importance of knowing in such case precisely what it costs to sell, as well as what it costs to make, cannot be denied.

The theory of general establishment charges may be briefly stated as follows:—Having produced certain articles which are found to have cost N., we have to spread away over such cost an additional amount, M., which we find represents the cost of selling the value N. at a profit. Now the cost of selling has not, as already remarked, any proportionate relation to cost of making at all. And the real difficulty of basing the incidence of general charges on shop cost is that these charges do not get higher as works cost gets higher in the majority

of cases, for the increase in cost of production is usually at the expense of profit. It is not often that the price obtained for an article is otherwise than ruled by the state of the market. And certainly accidental increases in production cost are at the expense of profit only in almost every case. If, therefore, we base the incidence of general charges as a mere percentage on wages, or on works cost, we are doing something which is very easy and simple, but which is almost sure to be very misleading in cases where there are more than one or two different classes of articles concerned. At the same time, it is evident that *some* basis of value must be taken before we can distribute at all. It is not practicable to isolate the expenditure on advertising, travelling, and so forth so as to debit each piece with the amount incurred on the selling of it; we have therefore to compromise the matter, and compensate the faults of the basis by a classification method which will enable us to discriminate between various classes of products. Even then there is a choice between three bases of value on which the general charges may be distributed.

General charges may be distributed: 1, on wages cost only; 2, on works cost; 3, on an hourly basis, according to the number of hours consumed in the production.

For ordinary manufacturing purposes, it is probable that the last method has the balance of advantages in its favour. The proposal will be understood if it is stated that the basis of distribution is an hourly-burden method. Also the entirely arbitrary nature of the basis will be strongly demonstrated. There is obviously no connection between selling expenses and the number of hours occupied in making. Neither is there any connection between wages, or prime cost, and the cost of selling. Many persons, however, are under the impression that there is. The reduction of the basis to hours instead of dollars or shillings will help to disperse this impression, which is of course without any foundation whatever.

Having decided on the basis for distribution, there is next the question of how to compensate for its arbitrary character. Its only merit is that it provides a common basis for distributing over classes of articles which may be very varied indeed, and it has, of course, a direct ratio with the activity of the shops during any period of which it is required to distribute the general charges. On the other hand, in cases where a factoring business in addition to a manufacturing business is done, or where the product includes heavy *purchases* of material, additional arrangements are necessary to deal with these variations.

If, now, we regard a given case in which there are, for example, three distinct products manufactured by the firm, one of which is a small item made in large quantities, and almost a "staple"—that is, a readily marketable product depending on the condition of the market for its sale and price rather than on any special efforts of the commercial arm to push it—the others being respectively an ordinary engineering device such as a lathe or pump, fairly well standardised and sold from catalogue, and finally a special class of thing, such as a crane, which has to be treated individually, involving a good deal of staff time for drawings, measurements, consultations, visits, etc., in each case—if we consider a case like this, it will be evident that to treat each of these classes alike in the proportion of general charges debited to it will be to do a serious injustice to the more easily sold things, to the benefit of the less easily sold. And when the question of what class of business it pays best to exploit is under consideration, this becomes a vital matter indeed.

It may perhaps be suggested that no system of establishment charges is required to inform a practical man on this point. And in the strongly contrasted cases which have been purposely selected, this may perhaps be so. But in proportion as the difference between classes becomes less, the problem becomes obscure. A shrewd guess may be made, and in the absence of actual knowledge must be, as to what is the most profitable class of several. The whole tendency of modern organisation is, however, to do away with the necessity for guessing at all.

It is necessary, notwithstanding, to beware of relying on figures unless the conditions under which they are true are well known. A misleading method is, of course, much worse than none at all. It is for this reason that the essential falsity of averaging general charges all round should be clearly recognised, just as it has been shown that the method is false for shop charges. And when, as is usually done, *both* these classes of charge are lumped together and averaged away over the work without any differentiation at all, it is difficult to avoid the conclusion that the practice is a dangerous one.

This caution is necessary at the point we have reached in the discussion of methods of dealing with general establishment charges. It is not pretended that the system here described is as final and accurate as the method of dealing with shop charges. These latter are real, and their connection with each item of work is also real. But as has been frankly admitted at the outset, the connection of general charges with work is not real, but entirely arbitrary and

conventional, from the very nature of the elements concerned. All we can hope to do is to approximate the figures to the actual facts, by further artificial means. Therefore the proportion of general establishment charges debited against any particular order must always be regarded with due reservation.

The most practical method of correcting the errors introduced by the artificiality of the basis of distribution, is by means of classification whereby the incidence which would otherwise fall equally on each kind of work is made to fall unequally. A number of classes are created, the incidence in the first of which is, say, 100, the incidence in the second being 120, that in the third and fourth perhaps 150 and 170 respectively, and so on for as many classes as may be found necessary. Leaving aside for the moment the considerations which determine in what particular class any given article shall stand, it is evident that if we have a thousand dollars to distribute, the first class will get off lighter and the last class will be more heavily debited than on an ordinary averaging plan. Therefore if any reasonable means of classifying articles can be devised which shall correspond as closely as possible to the differences in their commercial treatment, the arbitrary character of the original basis will be to a large extent minimised. There still, however, remains the objection which must never be lost sight of when consulting the figures, that an undue rise in production-cost will lead to a disproportionate absorbtion of general charges, in whatever class the article may happen to be.

The process of determining the classification is, unfortunately, somewhat difficult, or at least demands a good deal of thought and care at the outset. Space will not permit of its full treatment here, only the principle followed can be detailed. Every item of general charges must be tabulated. The average annual cost of advertising, travelling, drawings, patterns, catalogues, correspondence department, cashiers and book-keeping, management, and all similar expenditure must be got out and arranged in columns. These are the items of which the incidence has to be settled. Now against these has to be placed each of the different classes of articles manufactured, and each one of these has to be carefully reviewed with relation to each of the items of expense.

Thus, for instance, advertising. Analysis of the advertising expenditure may show that one article has practically no concern with advertising. Of this class an obvious example is repairs to the firm's own products. Other articles, on the contrary, may involve special advertising, and should of course be debited with the whole

of such special expense. Catalogues are open to similar analysis. Such items, again, as are standard articles supplied either from stock or from standard parts, involve much less of the expenditure due to correspondence than do special jobs. Repairs, on the other hand, although escaping the advertising debit, should be visited heavily on the correspondence and book-keeping sections, since these small jobs cause as much work to these departments as do standard orders of fifty or a hundred times their value. From this brief description it will be seen that the general establishment charges are capable of a very detailed analysis. It is true that the element of judgment is very strongly involved in this analysis, but there is a difference between judgment and mere guesswork. There is no reason why a very close approximation to facts should not be made at this stage if the work is carried out by a competent person, who has access to all the data necessary for decision.

The method of working up the analysed details into percentage figures on which the distribution of general charges is actually made will be better understood from an example. In the following table only three classes of articles have been taken, and only three out of the many items of establishment charges. The principle will be none the less clear.

TABLE SHOWING METHOD OF APPORTIONING DIFFERENT ITEMS OF GENERAL ESTABLISHMENT CHARGES ON DIFFERENT CLASSES OF WORK.

Class.	Output.	Advertising Exp.	Catalog Exp.	Correspondence Dep. Exp.	Totals.	Percentage of Incidence.
Standard lathes.....	$100,000	$7,000	$4,800	$1,660	$13,460	13½
Special cranes.....	20,000	3,000	200	1,340	4,540	22¾
Repairs.....	20,000	.....	.....	2,000	2,000	10
Totals.....	$140,000	$10,000	$5,000	$5,000	$20,000	*

* Average percentage would be 14¼ per cent.

The figures in the expense columns of the above table are obtained by carefully considering the items with reference to the output. Thus, on examining the advertising account, it was found that $3,000 was spent in advertising special cranes, leaving the remainder of that expense to fall upon the standard lathes. Catalogues, again, not containing more than a mention of the cranes, were adjudged to be borne almost entirely by the lathes. On the other hand, when the work and expenditure of the correspondence department was reviewed,

it seemed just to apportion the expense much more equally between the three classes. The result of these several apportionments, having been summarised for each class and the ratio established between them and the volume of business done, it is found that while as might have been expected the standard lathes which form the great bulk of the output absorb very nearly the average amount of incidence, viz., 13½ per cent. instead of 14¼ per cent., the other classes, viz., cranes and repairs, differ considerably from the average, the former taking nearly 23 per cent. and the latter 10 per cent.

In distributing general charges each month, effect is given to these percentages. The total expenditure being found, it is not averaged indiscriminately over the whole output for that month, but in such a manner that when all is distributed the proportion between the various classes is maintained. This is done by a very simple calculation, not demanding in its practical working anything more than common arithmetic. The result obtained is decidedly instructive. Assuming that the classification has been carefully made, the relative profitableness of any class of work can be ascertained. And if at any time it is found necessary to revise the percentage for any class, this can be done without disturbing other classes. For, as will be seen from an examination of the table above, if the percentage of any class is slightly reduced, it fails to absorb so large a proportion of the expenses, which consequently fall more heavily on all the other classes.

It must not be overlooked that a fundamental principle of the distribution is that the debit for general expenses shall be exactly cleared by the total of the allocation to classes. The percentages here express merely the *relations between the classes*, and not any definite percentage on values. If one class takes 10 per cent., another 15 per cent., and a third 20 per cent., this merely means that the general expenses, whatever they are, are distributed on the basis of that *relative* difference between the shares taken by each class. It does *not* mean that Class 1 gets 10 per cent. only on its value, but that if Class 1 gets a certain burden, Class 2 has one-and-a-half times and Class 3 twice as heavy a burden in proportion to hours or value. That is, if Class 1 has a burden of 4 cents an hour, Class 2 will have 6 cents and Class 3 will have 8 cents. The actual burden will, of course, depend on the amount to be distributed.

If then we find that any particular class is absorbing expenses to such a tune that there is no profit left when prime cost, shop charges, and general charges have all been debited, a prima-facie case is made out for supposing that this class is not remunerative at the

prices obtained. Before we can say that this is actually so, the basis of classification must be carefully examined to see if it has been assessed with undue severity on that article. This will perhaps involve some trouble, but it is eminently a case in which it will pay to spend trouble.

Between the shop charges and the general charges there is, then, this difference: While the first, if properly arranged in the first place, are subject to no appeal, as they are real figures and do show exactly what has taken place, the general charges may be looked on as rather in the nature of a danger signal which gives warning of a probable pitfall, but which may, if careful enquiry approves, be put on one side and its readings modified. It would be better, of course, if the figures pertaining to general charges were as real and reliable as those of the shop charges. But there seems to be no possible hope of their being made so. There is no visible and tangible result connected with concrete things in the case of general charges. Nothing is produced. Expenditure may, in fact, lead to no result at all—nay, does often lead to pure loss of money and time. It is this vagueness of the general charges that forbids our regarding them as bed-rocks on which we can base deductions without further enquiry. But there is no excuse for not making them as useful as possible, reading them as indications if not as facts.

Enough has, perhaps, been said about the character of these general charges to emphasise the remarks which have been made several times in the course of these articles as to the infinite importance of separating them from the shop charges. Mr. Slater Lewis's theory on this point is very clear and distinct, and should be studied by every manufacturer who cares for accuracy and clearness in place of confusion and mixed results in his accounts. It is not too much to say that any system of accounts which lumps both classes of charge together and averages them all round is entirely worthless. Far from being an improvement on a simple system of prime cost, it is probable that it may easily, by inducing a false security, be positively dangerous and worse than no system at all.

The conclusion of this series of articles has now been reached. An attempt has been made to develop in an orderly manner the method of dealing in an improved way with the very difficult subject of establishment charges. Endeavour has been made to show that present methods are not satisfactory in that they seek to mingle elements which have nothing in common, and which are, on the contrary,

naturally distinct. In particular it has been shown that the old idea of the machine rate was based upon a theory essentially correct, but incomplete. It fulfilled functions which were seen to be desirable, and which have been altogether neglected in the more modern methods that have succeeded.

The fault of the machine rate, or perhaps we may say its misfortune, was that it was born and came to maturity in the archaic ages of cost accounting, and that it therefore sinned against the most serious canons of modern theory and practice, viz., that whatever else is done, *every dollar of charges must be burdened onto some item of work.* The machine rate failed because in the first place it dealt with only one or two items of expense, usually interest and depreciation alone, and in the second because in the case of idle time it simply lost sight of the charges which were nevertheless still there.

The main feature of the system proposed, as will have been gathered by those who have followed these papers, is that not only do the new machine rates deal with nearly all items of shop charges on a natural basis, but by the device of the *supplementary rate* all the lost time is picked up and distributed separately, thereby leaving the significance of the machine-rate figures unalloyed by the accidental conditions of the shop at any time. Further it has been shown that the supplementary rate forms in itself a useful barometer of conditions.

Although necessities of space have prevented a full discussion of the complex subject of general charges, enough has perhaps been said to show that the principle of averaging is not the best possible. It has been demonstrated that a certain amount of connection can be developed, not between general charges and *individual articles,* but between such charges and *classes of products.* And while the results are not as precise and indisputable as in the case of shop charges, there is still a decided gain by effecting this connection as far as it can be done, the results being looked on as in the nature of a guide or warning rather than as positive and definite information.

The whole tendency of what has been said is to the effect that by suitable arrangements on the lines proposed, manufacturers should be in a position to get much further into touch with the details of their work than they have any chance of doing on present methods.

A few final observations may be offered on the subject of works accounting generally. Modern methods have taken their rise in the growing complexity of modern industry. They, like the industry itself, tend to become more complicated in proportion as the numbers of their factors increase. The snare of the "simple system" must

therefore be avoided. One cannot calculate the weight of the earth or the distance of Uranus by means of common arithmetic. Nor can anyone represent the thousand-and-one interlocked factors of a modern factory by means of a double-entry ledger and an office boy. And just as the whole science of navigation hinges on high mathematics, so the management of a considerable business turns upon intricate principles which are the horror of the rule-of-thumb man and the sheet anchor of the progressive man of business. Now one can traverse the Atlantic in an open boat and without the Nautical Almanack, but it is done more quickly and more surely in the Oceanic.

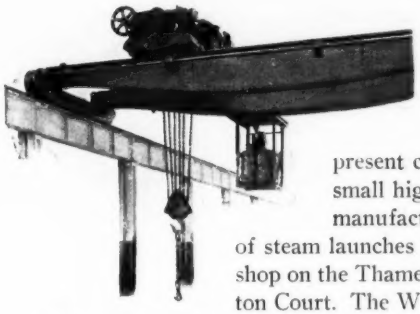
No system, however good, will give immediate results. It must be established, and must have run smoothly for months and even years before the full advantages are realised. For all progress is made by comparing what was done today with what was done some time ago, and this can be done to any purpose only when the basis of comparison is similar. From the nature of the case, no spasmodic efforts at the introduction of new methods are of the smallest use. To be of final and real commercial and technical value, records must be continuous and extend over various fluctuating periods of trade.

It will seem superfluous to many who read these lines to insist on the necessity of connecting the establishment charges as closely with costs as it can possibly be done, yet the truth is that comparatively few manufacturers are awake to this necessity. They do not realise that in all industries it is the narrowing of margins of profit, too often to the vanishing point, that has brought this question to the front. Fifty years ago, though there was a need (as evidenced by the tentative introduction of machine rates), there was not a pressing and imperative necessity for the manufacturer to look so closely and minutely into what he was doing. And only the "coming men" feel that necessity now. The older concerns will probably never come to that point, for they will have become exhausted in the effort to find out what was wrong with them.

ADVANCED METHODS IN A BRITISH ENGINEERING WORKSHOP.

By A. Lazenby.

In the great Works Management Number of THE ENGINEERING MAGAZINE, which appeared in January of this year, the first place was given to a study of "Lord Armstrong and the Elswick Works." Elswick was chosen as most typical of the historic engineering works which made England famous around the world, but especially as best representing the embodied genius of a single great inventive and organising mind. The works themselves are an example of growth by accretion. The Victoria works, described in the following pages by Mr. Lazenby, are characteristic of the newer age of British engineering progress. They stand, so to speak, as an example of growth by re-incarnation, and in this process they have been enabled to discard wholly everything obsolete and to build anew according to the latest ideals of practice. They stand naturally, therefore, as one of the best recognised examples of advanced British workshop management, and it is from that point of view they are treated here.—THE EDITORS.



THE firm of Willans & Robinson originated about twenty years ago in a partnership between the late Mr. P. W. Willans and Mr. Mark Robinson, the present chairman. Their specialty was a small high-speed marine engine, with the manufacture of which they combined that of steam launches and boilers, in a small river-side shop on the Thames at Thames Ditton, near Hampton Court. The Willans launch engine was the first high-speed engine which was really successful both as regards durability and economy, so much so that on the advent of electric lighting in Britain the suitability of the engine for the direct driving of dynamos was at once recognized. To fit it for this purpose, however, an important addition was made to it, in the form of the now well-known air-cushion cylinder, the invention of Mr. Robinson, and with this modification it came quickly into use for driving dynamos in Great Britain.

Various other improvements and modifications were made by Mr. Willans, which ended in 1884 in the evolution of the firm's present product—the Willans & Robinson central-valve engine. For many years past they have devoted themselves to it exclusively, the launch-engine business having been entirely given up.

In 1888 the firm was transformed into a private limited company, and in 1893, further expansion becoming necessary, the company was reconstructed with a larger capital. A site was purchased at Rugby, where excellent railway facilities as well as room for growth were available, (advantages which were both absent at Thames Ditton,) and the present shops were erected. Work was started in them in 1897, and already in the short space of three years several extensions have been made and a much larger one is now in progress, involving a doubling of the machine shop and a trebling of the foundry.

The new works well illustrate the leading principles which have guided the company since its earliest days, and which have contributed in no small degree to its success. They may be summed up in few words as follows:—the production of the highest quality of work attainable; the standardisation of the engine into certain definite sizes; strict accuracy of work, and interchangeability of all corresponding parts of the same size; adoption of all suitable labour-saving appliances and means for cheapening production; and the cultivation of good relations with, and care for the welfare of, their employees.

The works are situated upon a piece of land of about 23 acres in extent which adjoins the London & North Western Railway, near Rugby station. It was the company's aim in laying out the works, firstly, to arrange them so that the raw material entered at one end and in going through the various processes traveled more or less con-

ENTRANCE HALL, WILLANS & ROBINSON WORKS.

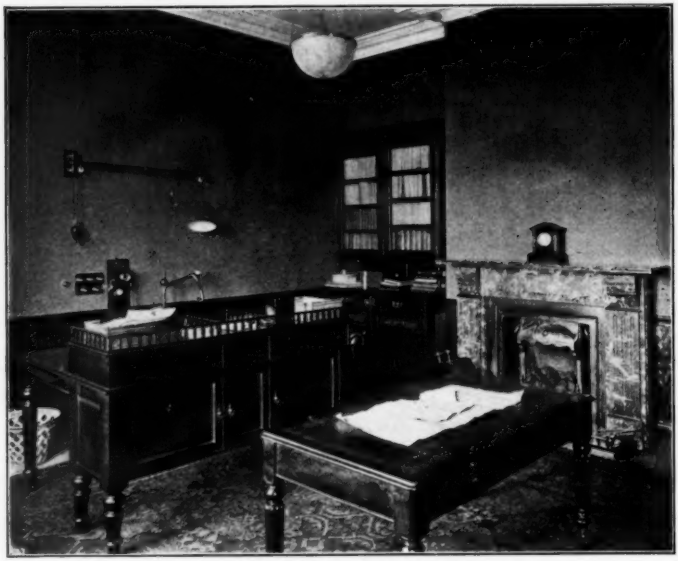
THE OFFICES AND GROUNDS OF THE VICTORIA WORKS, RUGBY.

tinuously in one direction through the works until it emerged in the shape of finished engines, or portions of engines, ready for despatch at the other end; and secondly, to make provision for easy extension, should it become necessary. The buildings were therefore designed to front upon a road which extends across the entire site, running nearly parallel with and close to the lines. The order of the principal departments starting from west to east is as follows:—

1. Foundry, with storage for coke and iron.
2. Casting stores.
3. Machine shop.
4. Manufactured stores.
5. Erecting shop.
6. Packing and forwarding department.

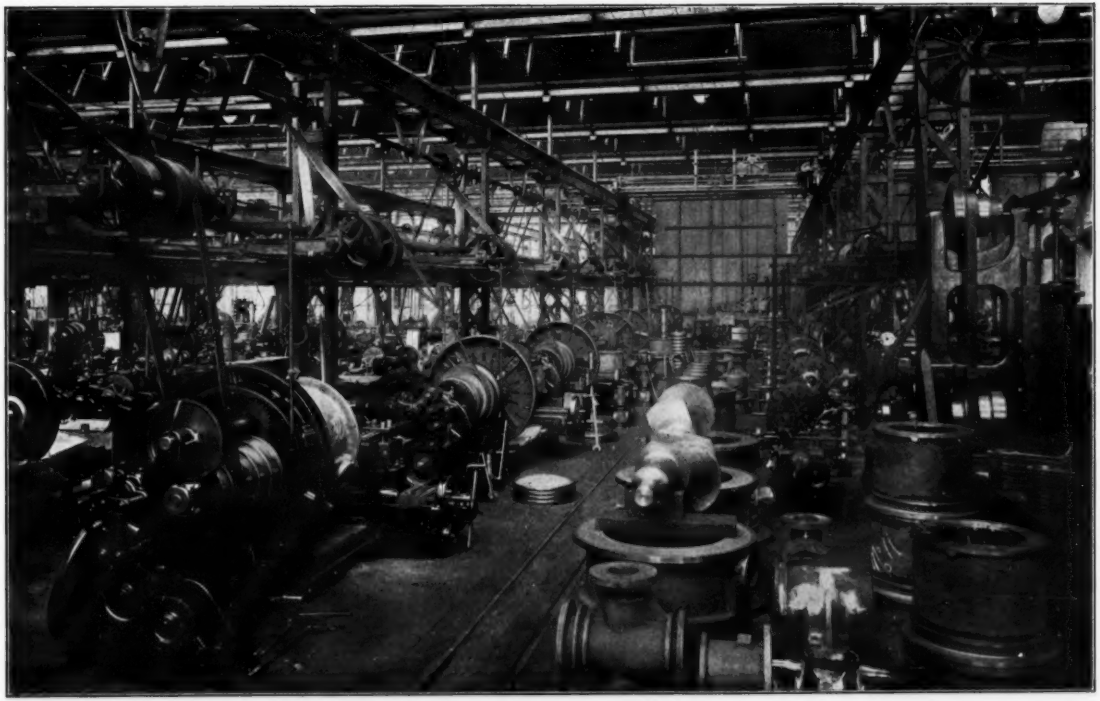
Beyond these again are the pattern shop and stores and the general offices, while the testing department is housed in a separate building some little distance away and connected with the erecting shop by a tramway. The buildings are all constructed upon one uniform plan; they are one storey in height and are divided into bays running north and south, separated from one another by lattice steel stanchions which carry the traveller girders and shafting. They also carry the roof, which is of the weaving-shed type with the light entering from the

north, and having the ridges and gutters running east and west. The buildings are incapable of extension sideways, but they may be lengthened backwards, i. e., to the south. The machine shop has already been twice lengthened in this way, and the foundry and the shop formerly intended for boiler making are now being greatly extended in the same manner. At the western end of the works stands the foundry with coke and iron stores on its western side, in the middle of which runs a railway track; at this side also are the two cupolas and the blowing engine. The building at present covers 22,000 square feet, which will be extended to 57,000 when the extensions in progress are completed.

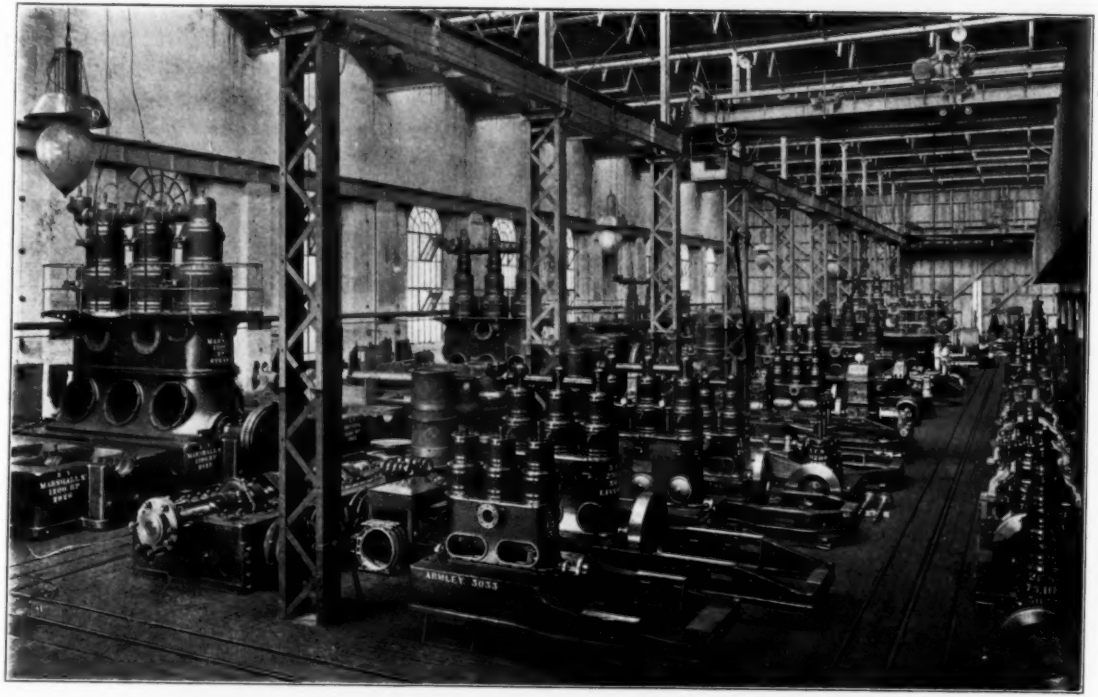


ONE OF THE DIRECTORS' ROOMS.

It will then consist of one 30-foot bay for pneumatic moulding machinery, etc.; one 60-foot bay 200 feet long for large castings; two 40-foot bays 400 feet long, and one 25-foot bay to be used partly as a casting store and partly as a pattern store. Among the special appliances in use in the foundry may be mentioned the pneumatic moulding machine and the Piftin stoves for drying the moulds by means of a current of hot air. The next building is the machine shop, which contains also the smiths' shop, manufactured and general stores, erecting shop, and works-manager's office, and which when completed will have a frontage of 500 feet and a depth of 240 feet. It will consist of six-

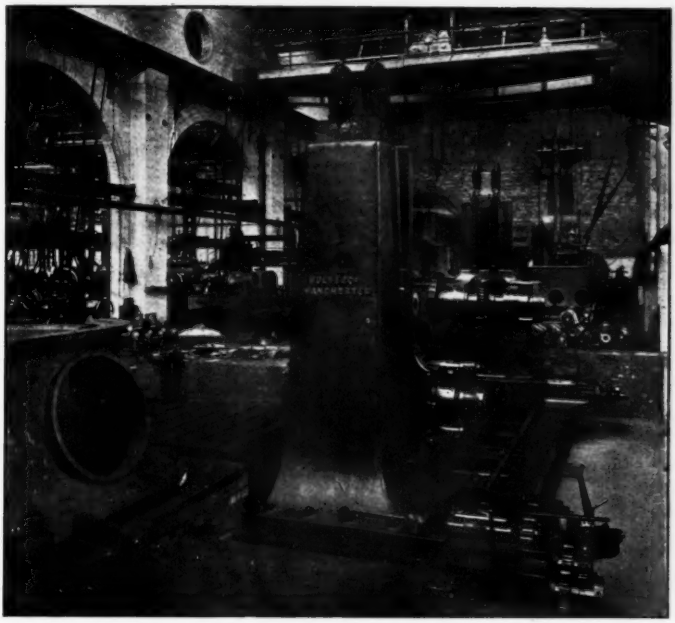


A BAY IN THE MACHINE SHOP



A PORTION OF THE ERECTING SHOP.

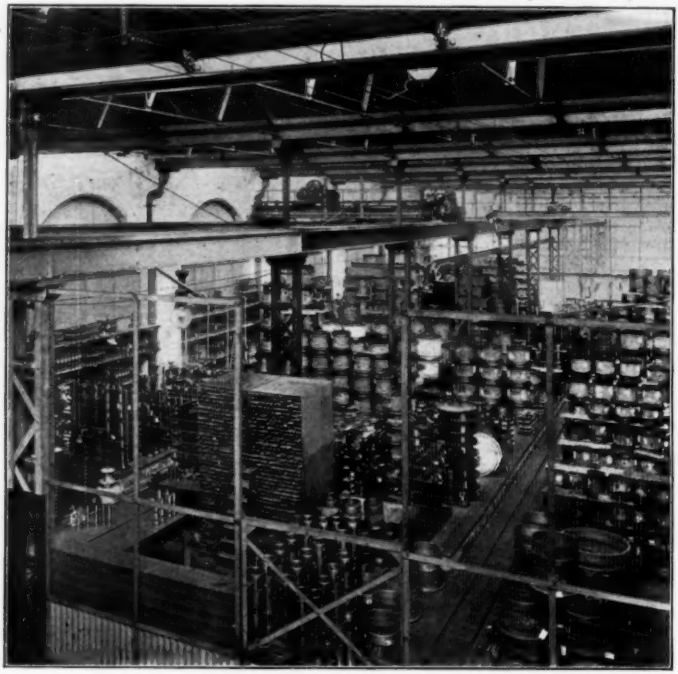
teen bays. Portions of Nos. 1 to 4 are already completed. No. 1 contains smiths' forges, and is separated from the remainder of the shop by a wall. The existing portions of Nos. 2 and 3 will contain crank-shaft lathes, and No. 4 a brass-finishers' shop, and the back portion will be devoted to the heaviest of the new tools. No. 5 is a new bay formed by covering an open alley between the existing buildings. It contains at present only a very massive 10 by 10 planer, made by the Niles Tool Company, under a temporary shed. No. 6 is a bay 40 feet wide containing the larger tools at present at work. Attention may be drawn to the large double-headed vertical milling machine



LARGE MILLING MACHINE IN THE MACHINE SHOPS OF THE RUGBY WORKS.

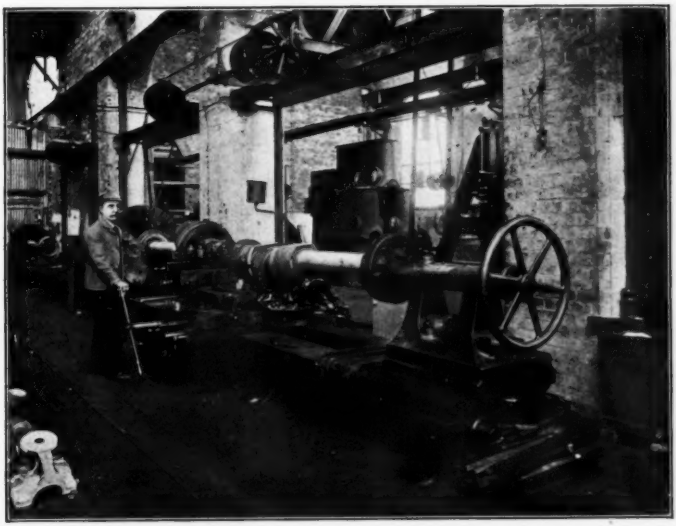
which is illustrated on this page. This tool has two standards, each with a vertical travel of 6 feet, a traverse of 2 feet, and a longitudinal travel of 18 feet. The bay also contains two very fine vertical boring machines, horizontal boring machines, and planers of various sizes. Nos. 7, 8, 9, 10, and 11 are machine bays each 22 feet wide. They contain some fine crank-shaft lathes and boring mills, which, however, are to be shifted into the new bays when they are completed, as well

as smaller tools, including cylinder-boring lathes, shaping and slotting machines, radial and other drilling machines, etc. No. 12 is a fitting bay for putting together steam-gland boxes, connecting-rod brasses, and the few articles which are usually fitted before being sent into store. It is also used for assembling orders for spare parts previous to dispatch. Nos. 13 and 14 are the manufactured-stores bays, where all finished parts are brought first for inspection, and then for storage. Nos. 15 and 16 are the erecting-shop bays, each at present 240 feet

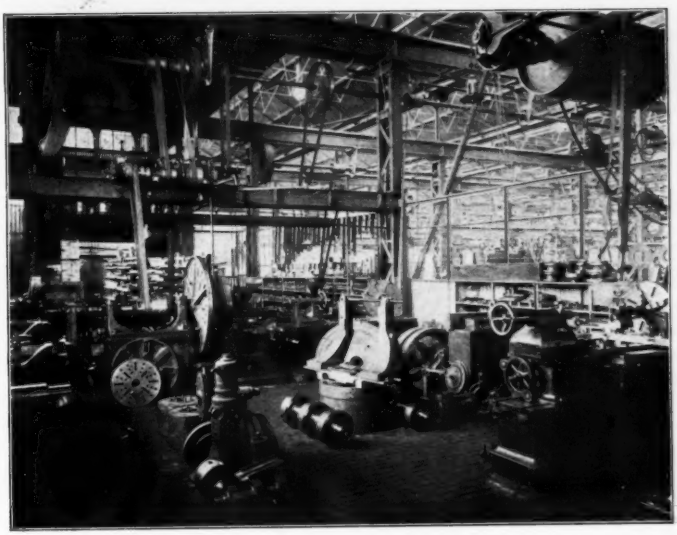


PART OF THE MANUFACTURED-STORES DEPARTMENT.

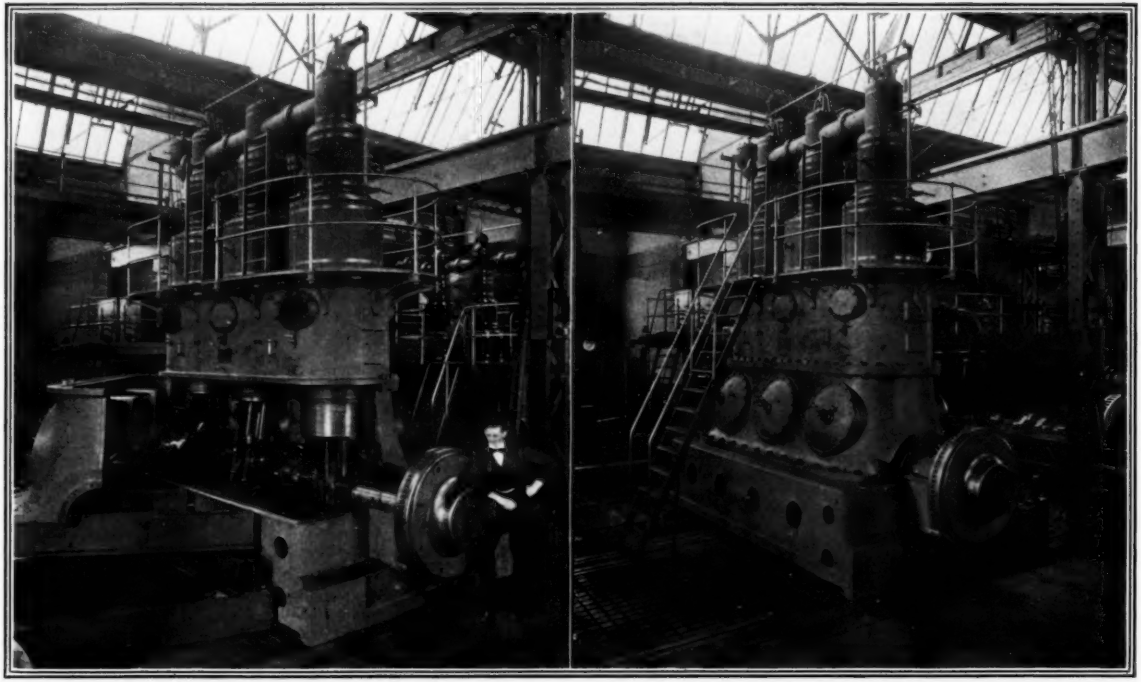
deep and 40 feet wide. Both will be lengthened towards the south by 80 feet, and No. 16 will in the new part be increased in width to 60 feet, and will be about 12 feet higher than the remainder of the erecting shop, which is already higher than the rest of the machine shop. The latter, though forming part of the same building, is completely divided from the erecting shop by a wall. Adjoining the erecting shop but separated from it by an alley, which forms the loading-out place, is the packing and forwarding shop, and behind it, next



CRANK-SHAFT LATHE IN THE MACHINE SHOP.



A PORTION OF THE TOOL ROOM.



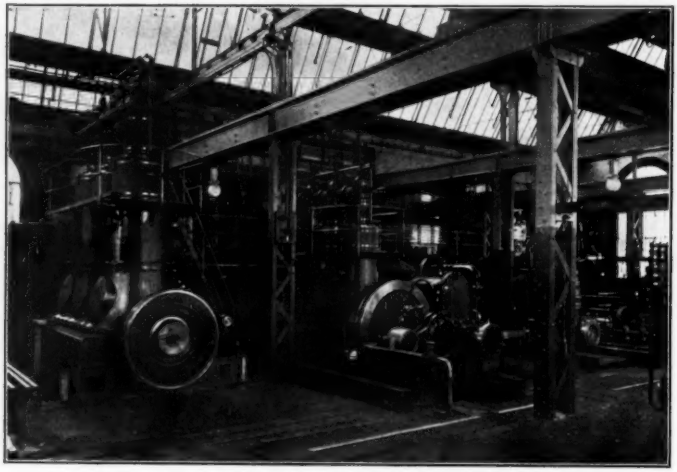
1,200-HORSE-POWER SET FOR THE LIVERPOOL TRAMS. THE VIEW ON THE LEFT SHOWS A PORTION OF THE CRANK-CHAMBER REMOVED, GIVING ACCESS TO THE CRANK-SHAFT, CONNECTING RODS, ETC.; IN THE RIGHT-HAND VIEW THE CRANK-CHAMBER IS SHOWN IN POSITION.

to the large extension of No. 16 bay, behind the forwarding department, will be placed the new power house, which will contain the engines and dynamos for lighting and for the electric driving of all the cranes, as well as of the machinery in the foundry and the new extensions of the machine shop. The present shop will continue to be driven temporarily by an existing engine and boiler situated in the front of the building. The remainder of this end of the shop is devoted to the tool and gauge department and the various stores. An overhead gallery contains the works-manager's offices. Adjoining the erecting shop on the east is the packing department and loading-out shed before referred to, which is commanded by a travelling crane and traversed by two lines of rails, one of standard gauge, communicating with the company's siding and running alongside a platform in the shed, and the other of 3-feet gauge for convenience in bringing goods alongside the trucks. The pattern shop forms one building with the packing department, and is adjacent to but separate from the pattern stores. The packing and pattern departments are kept entirely separate from the remainder of the works to minimise the danger from fire.

A siding from the railway of standard 4 feet 8½ inches gauge, with a large weighbridge at the entrance to the company's premises, runs along the front of the works direct to the foundry for the supply of raw materials. A similar and parallel line runs through the rear end of the foundry and machine and erecting shops, and the two are connected by lines passing, one down the west side of the foundry, and the other through the loading-out shed, with turntables at the angles. 3-feet and 18-inch tracks are also laid along this line, as well as through the front end of the machine and erecting shops, with connecting lines in all the bays. Branches of standard gauge also lead from the main siding into the erecting shop, testing department, and coal stores. The buildings are practically fire-proof, but very complete water service is laid throughout the works and offices.

The testing department is separate from the rest of the works. The main building has five north-and-south bays commanded by electric and hand travellers. The floor is of blue brick with grooved girders upon which the engines are bolted, and pits are provided for the reception of flywheels or dynamos which project below the engine bed plates. Steam is supplied by four 300-horse-power Niclausse boilers made by the company, and there is a very complete system of swing pipes by which engines can be connected to the mains. The energy developed is either absorbed by means of resistances if the

engine is driving a dynamo, or by a brake. One of Froude's water brakes, having a capacity of 700 horse power, is used for the larger engines. For making consumption tests the exhaust steam is condensed in surface condensers placed where required, and conveyed in pipes to a large tank standing upon a weigh-bridge and capable of holding some five tons of water. The arm of the weigh-bridge is placed in an office, in which are also collected the electrical measuring instruments and the bells for signalling to the attendants upon the engine

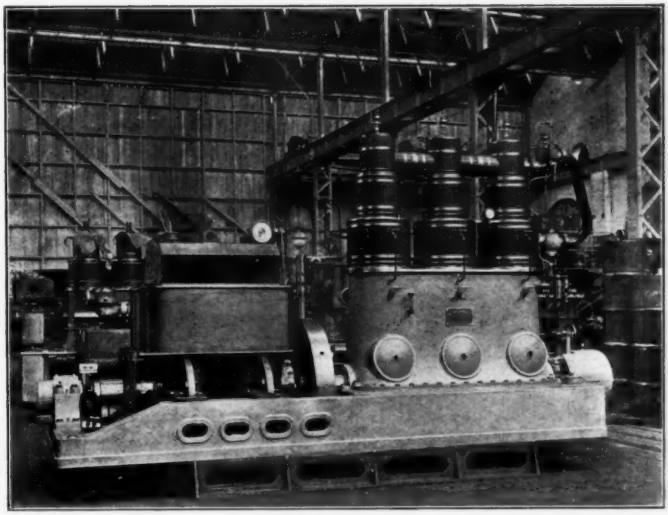


PORTION OF THE TESTING DEPARTMENT.

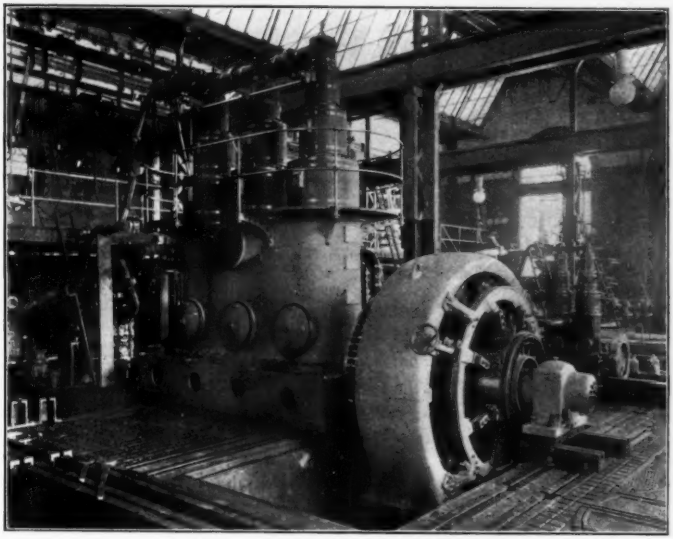
On the left is a 1,200-horse-power compound engine for the Liverpool Corporation Tramways, and in the centre a 575-indicated-horse-power engine for the City & South London Railway; this latter is coupled to a Froude hydraulic brake.

under test, so that the complete control of a trial is concentrated in one spot. The system of weighing the exhaust steam eliminates all sources of error in measurement, since only the steam actually used by the engines is taken account of, and results are obtained far surpassing both in speed and accuracy anything possible under the more usual system of weighing or measuring the feed water.

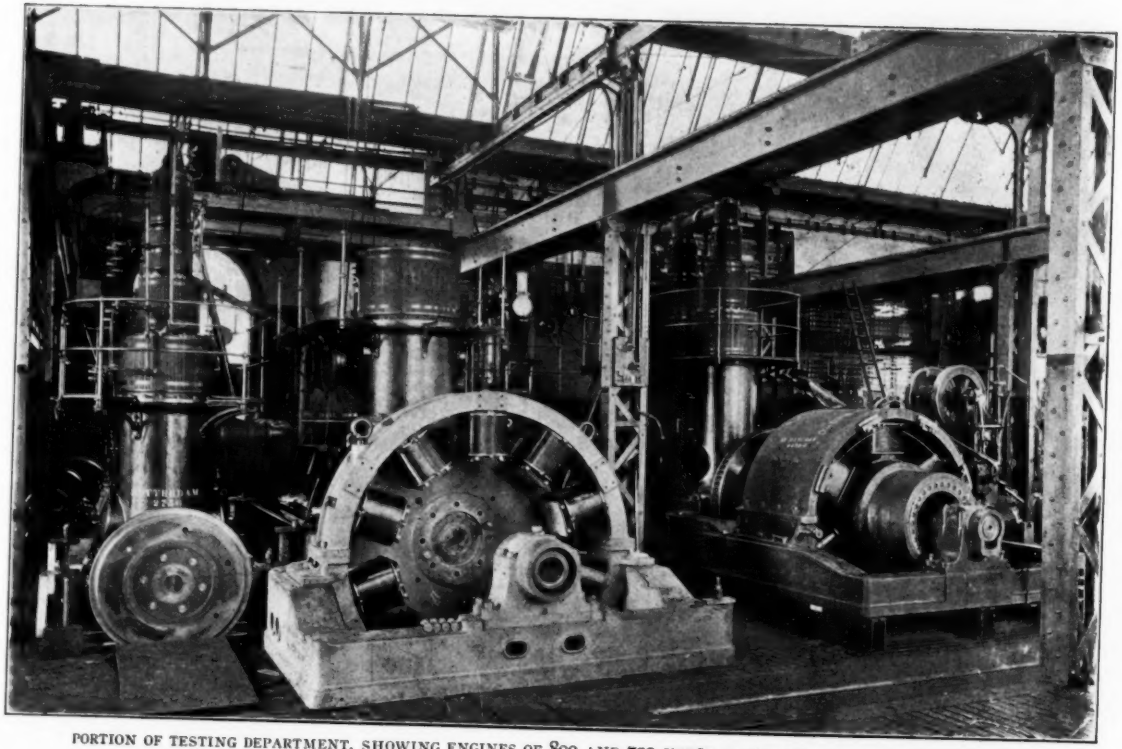
It has always been the policy of the company to standardise their products and to make all corresponding parts of the same size interchangeable. Even from the earliest days it was the custom to make "for stock," and when an order for a new size was received, to put in hand sufficient parts for half-a-dozen engines. This has been extended until there is now a large number of standard sizes ranging from 50 to 2,500 horse power, and a very complete and automatic



A PORTION OF THE ERECTING SHOP, SHOWING A 360-HORSE-POWER ENGINE AND DYNAMO FOR ONE OF THE LONDON STATIONS.



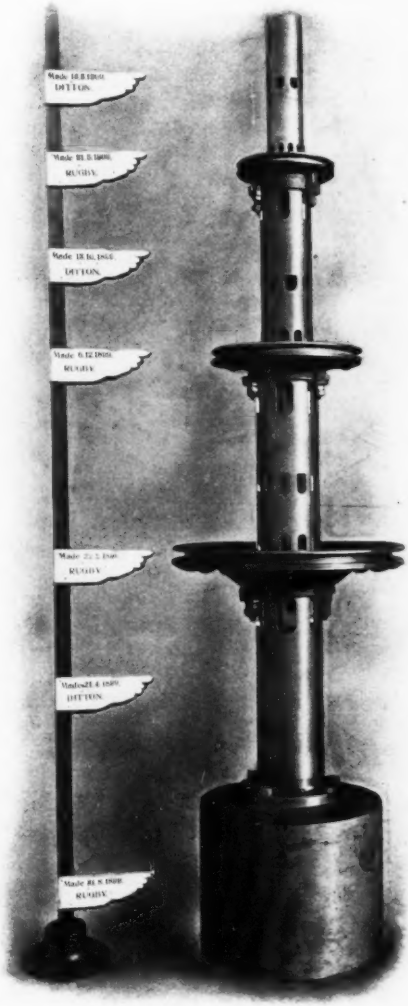
800-HORSE-POWER SET FOR PRESTON ELECTRIC-LIGHTING STATION UNDER TEST.



PORTION OF TESTING DEPARTMENT, SHOWING ENGINES OF 800 AND 700 HORSE POWER BEING GOT READY FOR TEST.

system by which the stock is kept up. The principal parts of each size are fixed and unchangeable, such as the crank shaft, bed-plate, connecting-rods, piston-rods, etc., but varying sizes of cylinders and pistons can be fitted to meet different conditions of steam pressure, etc. Care has been taken in arranging these variations to keep the total number of different sizes as small as possible by making each serve for more than one engine; for instance, the high-pressure piston rings of one engine will serve as the low-pressure rings of a smaller engine, and so on.

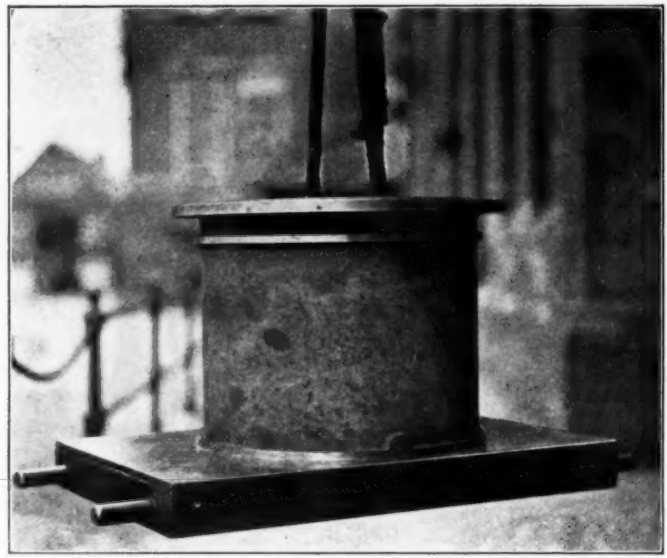
In order to insure the interchangeability aimed at, the different parts are invariably made in quantities, and an elaborate system of jigs, gauges, and templates is maintained and a special department forming part of the machine shop is set aside for their manufacture and **storage**. Here also all special tools, such as boring heads, etc., are made. This tool and template



A LINE OF MOVING PARTS, MADE AT DIFFERENT TIMES, PUT TOGETHER TO SHOW THE INTERCHANGEABILITY SECURED BY THE SYSTEM EMPLOYED.

department is provided with standard measuring instruments which have been compared with the standard yard and metre, for both systems of measurement are used. The gauges and tools are issued from this department to the workmen as required, and returned to it when done with.

All parts when completed are sent from the shops into the manufactured stores for inspection, and when passed are taken into stock. The manufactured-stores inspector is provided with a drawing of every piece, and on every dimension of each standard part certain limits of error only are allowed. If these limits are exceeded, or if the material or workmanship is considered defective, the part under examination is put aside with a report for the inspection of a director, whose decision is final.



CYLINDER AND FACE PLATE SUSPENDED FROM A PLUG GAUGE, AS DESCRIBED JUST BELOW.

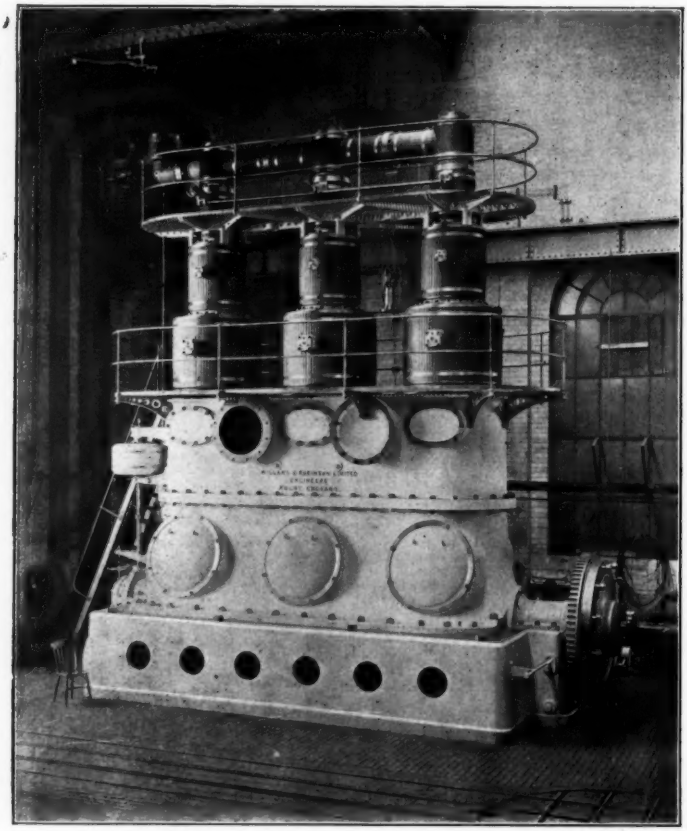
The following instance will enable an idea to be formed of the accuracy attained. The bore of a cylinder must not be less than standard in any case, nor greater by more than 0.0005 inch per inch of diameter in any part of the bore. Any cylinder which has passed the manufactured-stores test will, if inverted and placed upon a surface plate, allow the corresponding plug gauge, when inserted at the

other end, to float upon the contained air—the cylinder being clean and dry. The gauge will spin quite easily in the cylinder but it will not sink for several hours, and if it be lifted by a crane the cylinder and the surface plate will go up with it. This also tests the accuracy of the facing on the cylinder head, which is depended upon in these engines for making the joint between one cylinder and the next, no

THE DRAWING OFFICE.

jointing material whatever being used. The illustration on the opposite page shows the gauge suspended on the crane hook with the cylinder and surface plate hanging from it as described.

A certain minimum stock of each part of all sizes is aimed at, sufficient to provide for a predetermined number of engines, and when it falls below this, through the issue or appropriation of parts to engines on order, the stores inspector advises the works manager, who then passes an order to the works for a fresh batch to be put in hand. The work in the shops is therefore regulated by the actual quantity and sizes of the engines turned out, and a stock of complete engines is automatically provided. Upon an engine being ordered by a customer, a list of all its parts, standard or otherwise, is issued by the drawing office to the works manager, who draws the standard parts from the manufactured stores and puts in hand the non-standard parts, or, if they have to be obtained from outside firms, requisitions



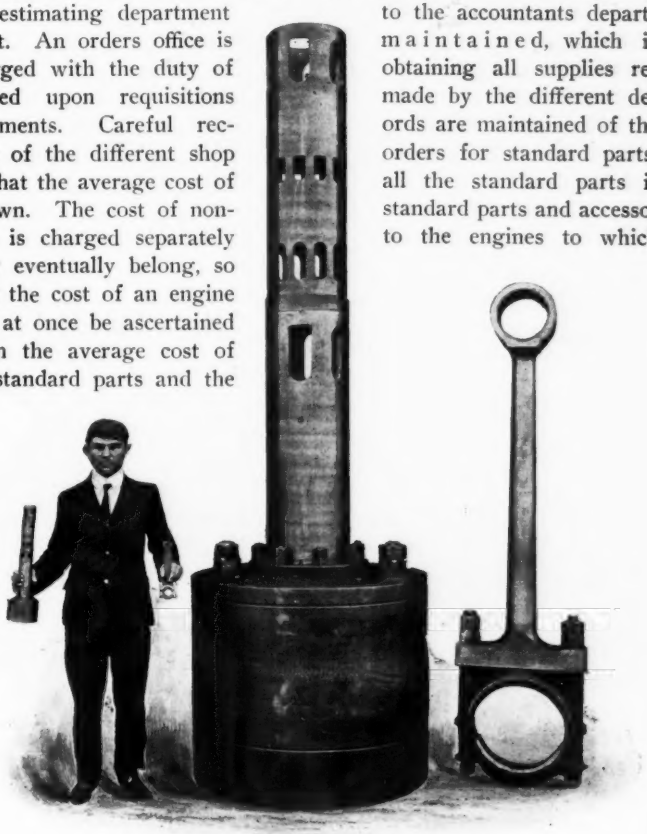
3,000-HORSE-POWER TRIPLE-EXPANSION ENGINE FOR THE PARIS EXPOSITION.

them from the orders department. This list forms also a permanent record of the engine and enables spare parts to be supplied promptly and accurately. Customers can be furnished with numbered sectional lithographs giving the names and numbers of all the parts of a Willans engine, and it is only necessary for them to state the number of the engine and the numbers of the parts required.

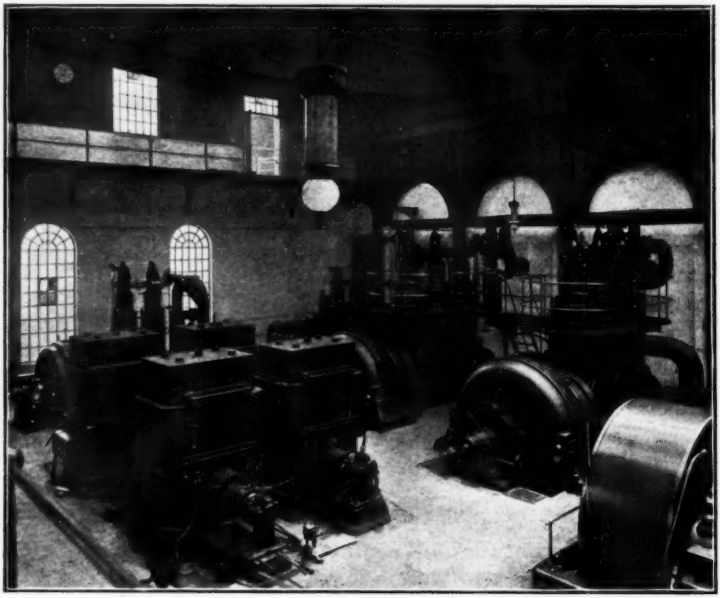
The general stores are separate from the manufactured stores, though under the control of the works manager. Goods are drawn from there by the various departments upon demand notes in the usual way. A minimum stock is also carried here, and replenished

as required by requisitions from the works manager to the orders office, which obtains supplies from outside firms.

The commercial offices are kept quite distinct from the works and technical departments. All correspondence relating to orders is carried on by the estimating department under the control of the directors, and full particulars of orders obtained are issued by it to the drawing office which in turn gives instructions to the works as already described. Particulars of the contracts are also furnished by the estimating department to the accountants department. An orders office is maintained, which is charged with the duty of obtaining all supplies required upon requisitions made by the different departments. Careful records are maintained of the cost of the different shop orders for standard parts, so that the average cost of all the standard parts is known. The cost of non-standard parts and accessories is charged separately to the engines to which they eventually belong, so that the cost of an engine can at once be ascertained from the average cost of its standard parts and the



THE LARGEST AND THE SMALLEST HOLLOW PISTON-RODS AND CONNECTING-RODS MADE.
The former are for an engine of 3,000 horse power, the latter for an engine of 3½ horse power.



GENERAL VIEW OF CITY AND SOUTH LONDON STATION, CONTAINING TWO 575-HORSE-POWER SETS AND ONE SMALLER ONE OF 250 HORSE POWER.

actual cost of its own special requirements. Where engines are made in large quantities, this system gives a perfectly accurate result and enables a very comprehensive and accurate idea to be formed of the cost of different pieces and processes.

In dealing with their workmen the company have adopted the premium system so far as is possible. Every standard part has a certain "reference rate" as a basis of payment, and if the workman produces it more cheaply the difference is divided in equal proportions between himself and the company. Certain regulations are in force for preventing the arbitrary cutting down of rates and so depriving the workman of his reward for increased skill, and the arrangement has been found to work satisfactorily to both sides. In the great engineers' strike of 1899, not a single man left the company's employment, and the only trouble experienced was from the difficulty of obtaining raw material. Most of the members of the staff received a contingent salary, dependent upon the general profits, in addition to their fixed stipend.

There is a voluntary sick club in the works, to which the com-

pany contribute annually a sum equal to the men's subscriptions. The surplus funds, including the company's donation, but less a certain amount to provide for current needs, are divided amongst the subscribers at the end of each year. The company have built a mess room, which is in charge of an attendant, who, in return for a small fixed wage, is allowed to supply meals at certain rates, and is also bound to cook the men's own provisions. Bath rooms and lavatories are provided in the basement of this building, which also serves for meetings, entertainments, etc.

The unoccupied portion of the company's premises is let as allotments to the workmen at a small rental, upon condition of its being resumed by the company should it be required for any other purpose.

Messrs. Willans & Robinson now employ about 950 men, or double the number employed at Thames Ditton just before the works were moved to Rugby in 1897, while the output has increased in an even greater proportion. In laying out the Rugby works, provision was made for engines of 800 horse power as a maximum size, but so rapidly have the sizes and demands grown, that more than thirty of 1,500 horse power have since been constructed, as well as several of 3,000 horse power, one of which was at work in the Paris Exhibition where it drove a dynamo for supplying light and power.

THE GOLD-DREDGING FIELDS OF EASTERN RUSSIA.

By C. W. Purington and J. B. Landfield, Jr.

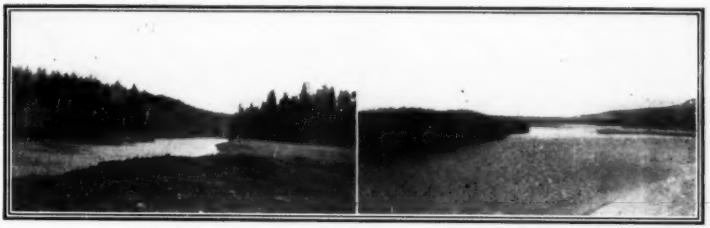
Russia is of so vast importance industrially, and above all as a field for engineering development, that accurate information as to its resources and possibilities is very valuable. We are particularly glad, therefore, to be able to supplement Mr. Purington's recent article on Siberian gold-mining with this authoritative sketch of the opportunities for gold dredging. It will be followed by a digest of the Russian mining law so far as this concerns the precious metals. The illustrations are from photographs by the authors.—THE EDITORS.

Iron Monument Marking the Boundary between Europe and Asia on the Kooshva-Kungur Road.

GOLD-DREDGING enterprises, in whatever part of the world they were instituted, were for many years entirely unsuccessful. They labored under the disadvantages attendant upon all ventures of an entirely experimental character. As a result of the attempts to win the values from gold-bearing gravels so situated that the ordinary methods of placer-mining were unavailable, gold-dredging presented to the operator many difficulties of a novel character.

At the present time this form of placer mining may be said to have acquired the status of a permanent industry. The numerous conditions besides the actual tenor of the gravel in gold, which, as in other kinds of mining, must be taken into consideration in starting a dredging enterprise, are of a character so peculiar that they merit considerable notice. It has been the non-observance of the adverse conditions which has caused the downfall of so many promising schemes for dredging river-beds with the purpose of winning gold. On the other hand, it has been the concurrence of suitable natural features of the ground, together with the operation of machinery fitted to its peculiar surroundings, which has made gold dredging successful in the few localities now attaining prominence in this regard.

Although it is the purpose of this paper to call attention to the fields



ON THE LEFT IS A TYPICAL STREAM OF THE NORTHERN URAL. IN THE GRAVEL BAR OF THE LEFT BANK, GOLD MAY BE PANNED AT SURFACE. THE RIGHT-HAND VIEW IS A TYPICAL VALLEY OF THE STEPPES, SOUTHERN URAL, FILLED WITH AURIFEROUS SAND AND GRAVEL.

for gold-dredging lying in Eastern Russia and Siberia, it seems important that a brief review be given of the fields where the gold-dredging industry has attained some importance, in order that a better comprehension of the whole subject may be had. New Zealand furnishes the most successful examples of gold-dredging. Although the conditions for operating in the swift, short, New Zealand rivers can by no means be said to be ideal, the work is there conducted at a cost less than has so far been practicable in the United States. Dredging operations are also carried on successfully in Australia, though to a less extent. Alaska has been the seat of many attempts at gold-dredging, none of which, so far as known to the writers, have been successful. British Columbia has seen the installation of several dredge-boats, the operation of which has been more or less profitable. In various portions of northern South America attempts at gold-dredging have been made, which have been for the most part complete failures.

In the United States, dredging for gold is now carried on in California, Washington, Idaho, Montana, Colorado, Utah, and northern Georgia. The instances of failure have undoubtedly been much more numerous than those of success, but it may be said in general that the dredges operating in the rivers tributary to the Pacific Ocean have done the most satisfactory work, up to the present time, of any of the boats operated in the United States. The most notable instance of gold dredging, and that which best exhibits the growth of the industry in California, is the present activity in this line at Oroville, Butte County, on the Feather River. Within the space of eighteen months, the number of working dredges, each handling from eight to fifteen hundred cubic yards of gravel in twenty-four hours, has increased from five to twelve, several more boats are now building, and the available auriferous land has increased during that time from two to five times in price. The gold-dredging industry at Oroville is without

doubt a financial success, as the increasing number of operations in the district round about goes to prove. On the other hand, in California itself, the most glaring failures have occasionally resulted from well-planned dredging operations. In the case of failure, too, machines and methods were employed almost precisely similar to those now in use at Oroville.

It is the opinion of the writers that natural conditions of a peculiar character are necessary as an accompaniment of the values in any locality where it is proposed to win gold by the method of dredging. Recent experience has proved that the greatest attention must be given to the topographic and geological conditions of the country in which the enterprise is to be inaugurated. Otherwise success in the operations is not to be looked for. For the sake of clearness, the following explanation of the necessary conditions for a dredging proposition is given.

Taking the country about Oroville as the best example in the United States, let the geological conditions be considered. To the north and east, the erosion of a vast extent of mountain country whose rocks are penetrated with gold-bearing veins has contributed, little by little through geologic ages, to the mass of detritus now occupying the bed of the Feather River. A wearing down of mountains, originally very much higher than at present, through a vast amount of time, has caused the formation of a valley of extraordinary width but of no great depth. The massing of stream-detritus is also responsible for a decrease in the gradient, and a slowing-down almost to a topographical equilibrium of the formerly swift current of the river. The stream, unable longer under these conditions to cut its way by virtue of the material which it carried in suspension, has for a long time been depositing its load, filling its wide valley with sand and gravel, together with the less destructible of the metallic particles, and notably, gold. Geologically speaking, the rate of deposition of the river's material may be said to be on the increase, and the current of the water, still of considerable velocity, to be gradually lessening in swiftness. Later in its geologic cycle the Feather River will doubtless assume, on a smaller scale, the present character of the Mississippi, forming ox-bow curves, cut-offs, and, as it were, losing its way among constantly shifting sand-bars.

The accompanying residual gold, as it travels to a greater and greater distance from its original source in the veins of the mountains, becomes more and more finely divided, even to microscopic dimensions, increases in purity, and the degree of evenness with which the parti-

cles are distributed in the gravel becomes a phenomenon of constantly increasing definiteness and importance.

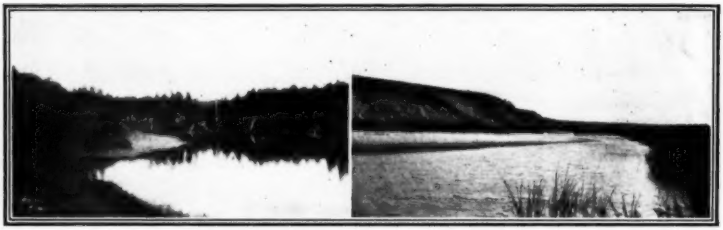
Such a set of conditions as that obtaining on the Feather River is the exception rather than the rule in the western part of the United States, and even in California. The above explanation has been entered into in order to present in some measure the reasons why, on the California river referred to, the conditions are not only favorable but eminently suited to gold dredging. Shallow gravels, that is, those less

TYPICAL GRAVEL FLAT, NORTHERN URAL.

than forty feet in depth, are an essential in dredging enterprises. Thus broad, rather than narrow gorge-like valleys, must be sought. Bedrock of a soft decomposed character, which can be easily cut into by the dipper or bucket of the dredge, is a necessity, since the placer gold, by virtue of its gravity, often sinks from one to two feet into the crevices of the rock underlying. It is hardly necessary to state that the amount of gold increases in geometrical ratio, the lower it lies in a given bed of gravel. Thus old, rather than young valleys, are favorable for dredging.

An additional reason of great weight why geologically old valleys should be looked for is that the size of boulders is greatly decreased, gravel becomes by long abrasion uniform in size, the angularity of the fragments disappears, and a bed of pebbles, rounded and easily handled, is the result.

The even distribution of the gold, which, as mentioned above, is an invariable accompaniment of old and wide valleys, is a point in favor of this sort of mining, looked at from the standpoint of a business enterprise. At the same time it is evident that the finely divided state in which such gold is found necessitates the highest skill in the recovering of it. For example, at Oroville, although some of the operators are saving gold the subdivision of whose particles is almost microscopic, it



ON THE LEFT IS AN AURIFEROUS GRAVEL BAR IN THE NORTHERN URAL; ON THE RIGHT, THE UI RIVER, SOUTHERN URAL.

is thought with good reason that a considerable percentage of the values is lost in the water used for washing. In this case the particles of gold are so exceedingly fine that they will not settle in still water in the space of several hours.

The consideration of the ordinary conditions which are looked to in connection with any mining enterprise, such as transportation, labor, source of power, supplies, etc., need not be entered into here. It has not been so much the failure to consider these as it has been the disregard of the natural conditions above set forth which has, in nine cases out of ten, caused the failure of dredging enterprises. This statement will be appreciated by all those who have been connected with the business of gold dredging, whether or not they have made a success of their undertaking.

While the mineral-bearing portions of the United States may, for the most part, be said to be geologically young, the vast gold-fields of central and northern Asia offer conditions which are exactly the opposite. It has been stated that broad shallow valleys, filled with gold-bearing gravel, such as that of the Feather River, are in the United States the exception rather than the rule. In the auriferous portions of central and west Siberia and eastern Russia, such valleys are decidedly the rule. There, as for example in the Ural mountains, an amount of time inconceivably long has elapsed since the commencement of the erosion of the present drainage systems. Even the Altai, a mountain-system in which certain peaks exceed ten thousand feet in height, shows the marks, by the dome-like character of its summits, the great width of the intervening valleys, and the uniform breadth of the streams for long distances, of an exceedingly old mountain region. Perhaps more extraordinary still is the uniform topographic character of Siberia over its entire east and west extent. The greater part of it may be best described as a gigantic rolling country, with rounded hills and mountains and broad flat valleys.

Especially in the portion of eastern Russia known as the Ural region do the above-described conditions obtain in the completeness of their development. The Ural mountains are, in fact, for the most part low, rounded hills. In the vicinity of the main line of the Trans-Siberian railroad there are no peaks which exceed 3,500 feet in height, while the highest points in the Ural mountains do not exceed 6,000 feet above the sea. Immense areas within the limits of this region are almost level, or if they possess any elevations, they form only a rolling prairie-like topography. High mountains have undoubtedly occupied the areas now presenting a plane surface to the eye, but these mountains have been eroded, leaving nothing but their indestructible *débris* behind, consisting for the most part of quartz pebbles with the accompanying rolled particles of gold. Streams which were once torrents now wind about in broad flat valleys filled with gravel. Often it is the case that even the streams have ceased to flow, and their former valleys are now occupied by shallow lakes, or bogs full of standing water. Peat deposits are not uncommonly found covering the surface of the bogs, a result, doubtless, of the successive quick annual growth and decay of the luxuriant vegetation which prevails. From latitude fifty to sixty north along both the east and west slopes of the Ural divide

DREDGING GROUND, NORTHERN URAL, SHOWING DEPTH OF TURF COVERING.

are found the winding rivers and their tributaries, of the character described, in extraordinary abundance. They are frequently bordered by immense swamps, having a width of from one-half mile to five miles. In traveling through the swamps one frequently comes upon crescent-shaped lagoons, far away from the present bed of the river, but which represent old channels through which the river formerly made its way. These are precisely analogous in origin to the lagoons formed along the Mississippi, by its "cut-offs."

The importance of the existence of streams and swamp conditions of this character, considered from an economic standpoint, lies in the fact that the gravel beds underlying the areas in question are the result of the wearing-down, through geologic ages, of mountains containing auriferous veins. That, further, the rocks composing the mountains are for the most part slates and metamorphic schists, standing on edge, from their position and lithological character extremely subject to decay. That, finally, the auriferous gravel deposits underlying the rivers and swamps, though wide, are comparatively shallow, and are underlain by a floor of the same decayed slates and schists which compose the mountains. Thus it will be seen that the conditions requisite for dredging operations, as outlined previously in this paper, are, in the Ural region, of wide-spread occurrrence.

TESTING GOLD-DREDGING GROUND BY PIT SINKING, NORTHERN URAL.

Gold placers have been worked in the Ural and in Siberia for many years, but with rare exceptions no attempts have been made to extract gold from the gravels lying below the level of the surface water. Ill-considered attempts at dredging have been made in a few instances on the tributaries of the Amoor river in east Siberia. These were failures, principally on account of the shortness of season and the distance from repair-shops. In the Ural, peasant operators have long obtained gold and platinum from the rivers by the practice of "boat-shovelling," a method formerly used to some extent in the south-eastern part of the United States. This method, however, which employs no machinery more elaborate than a hand-windlass, is necessarily limited in capacity. Within two years dredges of the New Zealand and American types have been installed in the Mariinsk district of west Siberia. Reports from the New Zealand dredge, the only one in operation during the season of 1900, leave no question as to its complete success.

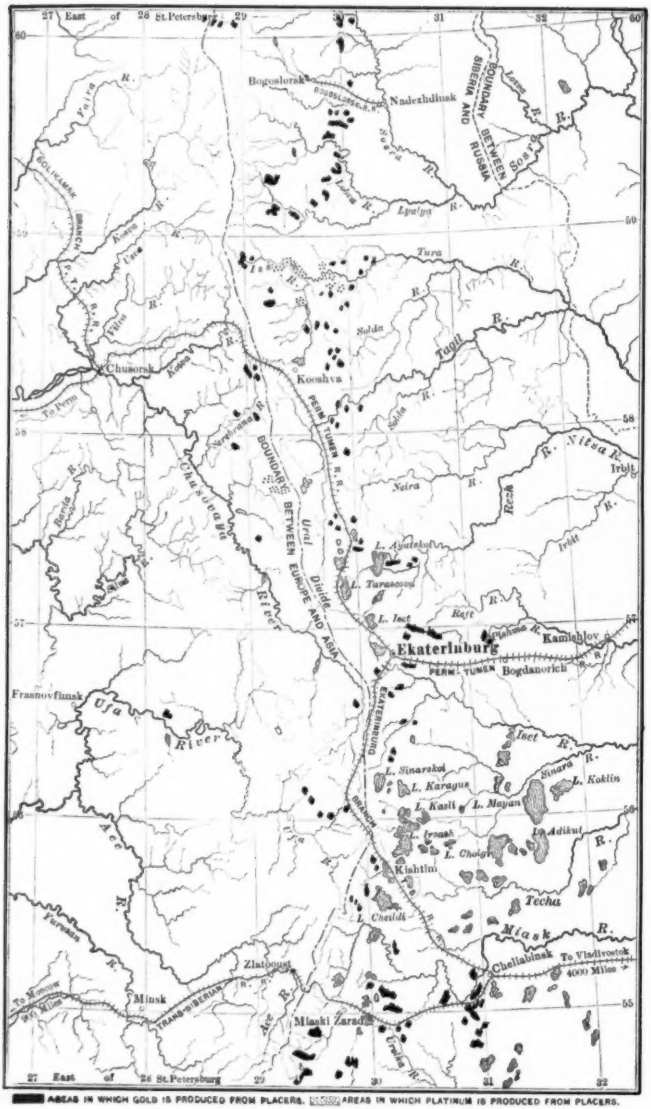
TARTARS, KOCHKA GOLD FIELDS.

Already, as a result of the reports of the profitable dredging in other portions of the world, much testing of the Ural and Siberian dredging ground has been done. In a typical area in the Ural, where tests were made under the direction of the writers, the conditions of gravel beds covered by swamp were found with an extraordinary degree of uniformity along the stream for a distance of thirty miles. The stream wound through the flats, its width varying from seventy-five to one hundred and fifty feet. The average width of the gravel bed was two thousand feet, its depth fifteen feet to bed rock, and it was covered by a layer of loam five feet in thickness. The bed-rock, a chloritic schist, was soft, and could be easily dug into with a pick to the depth of five feet. The average size of the rounded pebbles taken from the pits was not above four inches. An extraordinary uniformity of conditions was found to exist in portions of the area several miles apart.

Gold was found throughout the whole mass of gravel at the rate of twenty cents to the cubic yard of gravel. "Colors" of gold could be panned in the gravel taken from the river-bank, it being estimated that this surface material ran about three cents to the cubic yard.

The size and shape of the particles of gold from this river, as well as from many others tested, are very similar to those obtained in the dredging operations on the Feather River in California. A timber growth, birch, spruce, and fir, had originally covered the gravel flats, but had been partially cleared away by the peasants for the purpose of raising hay. In consequence, broad meadows bounded the river on both sides for long distances. An evidence of the wide extent of the conditions found along this stream is the fact that at a distance of three hundred miles to the south

A FOREST GUARD, NORTHERN URAL.



MAP OF A PORTION OF THE URAL REGION, EASTERN RUSSIA.
Showing the extensive development of drainage systems.

of it, another deposit was examined, and almost the same conditions were found to obtain. The principal difference was that, the southern area being in the steppe region, no timber covered the ground. As to the tenor of the river gravels in gold, it is not unlikely that many of these vast flats contain gold in too small quantity to be worked with payable results. The cost of gold dredging in the Ural and in the accessible portions of west Siberia should not exceed six cents per cubic yard of material handled. This being the case, it cannot be doubted that there exists in the territory in question a large amount of payably auriferous dredging ground. The map accompanying this paper gives an idea of the wide development of river systems in the Ural alone.

URAL LABORERS.

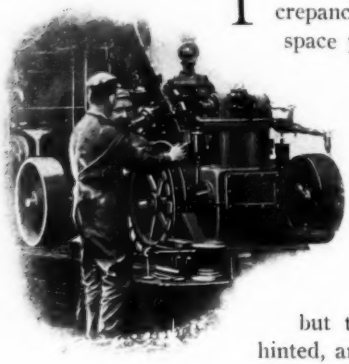
A working season of six months may always be counted on in those portions of Siberia west of the Yenesei river, whose northern limit may be roughly taken as an imaginary line drawn parallel to, and two hundred miles to the north of, the Trans-Siberian railway.

The region adjacent to the Ural is the most attractive field, considered from the gold-dredging standpoint. Its accessibility to railway transportation, the abundance and cheapness of labor, and the existence in it of machine shops of a high order of excellence, are all points which the prospective operator would be apt to consider favorably. In west Siberia, it is not likely that the deposits capable of being worked by dredges will be found to be any richer than those of the Ural, but the drainage areas are greater, the valleys wider, and the streams longer, consequently the total available area should be considerably more extensive.

A PROJECT FOR A BUREAU OF ENGINEERING DATA.

By Leicester Allen.

Mr. Allen in his argument does not at all intend to ignore what is being done nationally in Britain, by various Continental governments, and to some extent by the United States, in the way of establishing bureaus of engineering data; he merely pleads for the extension of the movement, particularly in the field of dynamic engineering. Static work has long had such aid through the establishment of comprehensive surveys—geologic, topographic, hydrographic—through astronomical observations, and weather bureaus. Mr. Allen proposes that the enormous growth in the importance of power engineering should be recognised by corresponding national—or international—assistance in those matters which are manifestly beyond the power of individuals or societies.—THE EDITORS.



IN a former article I set forth some of the discrepancies of precept in machine designing, space permitting the presentation of a summarized view only, not an exhaustive one, of the conflicts of opinion on the theoretical points, the discrepancies in data, and the compromises which designers are forced to make in a single department of mechanical design—steam engineering. The nature of the remedy was indicated at the end of that article, but the means of securing it was merely hinted, and is, I think, of sufficient importance to merit further discussion.

The conflicts, discrepancies, and compromises are by no means confined to any one department of engineering, but are distributed over the whole field, some departments showing more than others, but none being wholly exempt. In hydraulic engineering, for example, there are more than a score of different formulæ for the computation of thickness of cast-iron pipes. In 1894 the American Society of Mechanical Engineers, and Master Steam and Hot Water Fitters' Association, through committees appointed by each, acting conjointly, agreed upon standard sizes and dimensions for pipe flanges, the want of uniformity being a source of great annoyance particularly to heating and ventilating engineers. But within two years I have heard com-

plaints that this standard is not universally followed. The sizes of wrought-iron pipes have been standardized by some of the leading manufacturers, but there are still iron pipes sold which vary enough from the standard to exact too much labor in cutting threads corresponding with standard fittings, or to compel deficient threads. There is still a difference of opinion and practice on the subject of screw-threads, owing to the difficulties in applying a refined standard like that worked out by Mr. William Sellers, recommended by the Franklin Institute in 1864, adopted since by the United States army and navy departments, and now known as the United States standard The desire to adhere to this standard has, however, been so strong as to give rise to limit gauges which indicate whether the iron designed to be screw-threaded is larger or smaller than a certain allowable variation from the correct size necessary for cutting a perfect screw-thread in accordance with this standard.

The opinion that the straining of a metal piece of machinery merely beyond one of its elastic limits does not injure it, but that injury results from straining beyond its elastic limit of tension and that of compression alternately and repeatedly, has much experimental evidence to sustain it; but the subject of elastic limits and their relation to endurance under dead and live loads, loads suddenly applied and removed, and shocks, needs further and exhaustive investigation till such definite and uniform results are obtained as will establish laws of endurance beyond any question. This is not to withhold full credit for the valuable work already done by experimenters of highest ability, but to demand much more work on the same lines. Facts of such fundamental importance must be made the subject of so much corroborative experiment that their acceptance is as compulsory as assent to the law of falling bodies, or the conservation of energy.

In casting and forging, though notable advances have been latterly made these very advances indicate how much yet remains undetermined. In tool steels and their management there is yet much to be learned. Of the innumerable possible alloys, there are probably not more than two hundred, taking all the arts of construction and manufacture into consideration, which have been investigated and found valuable and useful. That this field of discovery is exhausted, or even nearly exhausted, or that fifty years of thoroughly organized and systematic laboratory work in this one line of investigation would discover all there is in it, who that has given close thought to the subject can believe? The work that has brought to light the now known useful alloys has been, to say the least, desultory; what might not be

expected from systematic effort of able investigators solely directed to discovery and investigation of alloys, in a well equipped laboratory fitted up for this single end? The announcement of one of the latest of possible metallic combinations, magnalium, even if time shall prove that it does not possess all the valuable properties at present claimed for it, indicates what may be reasonably expected from systematic work in this broad field of study.

The study of building materials and cements, and also materials for paving streets, is far from complete. The preservation of metal structures is a problem as yet only very partially solved. In heating and ventilation there are yet many moot questions. In gas engineering there remains open debate upon many important points of vital and fundamental interest. Discussions and disputes upon undecided points are found in almost every issue of publications devoted to electrical engineering. In mining and processes for reduction of ores, invention still proves that we are very far from having reached a finality, and the chemistry of the subject is in an unsettled state on some important technical points. Machinists are still at variance, both in theory and practice, as to the best proportions of the teeth of gear wheels. They are also not agreed as to whether involute or cycloidal teeth are the better. The uncertainty of factors which enter into formulæ for computing the strength of the teeth of wheels gives rise to much divergence in the formulæ themselves. The highest speed at which gearing ought to be run is also in dispute.

Lubrication, though it has been much studied, needs further investigation; the results of modern experiments not only give different co-efficients of friction from those once accepted as valid, but the relations of speed to friction as laid down in some modern textbooks and books of reference should be absolutely confirmed for practical and ordinary conditions, or disproved by revised and prolonged experimental investigation. The whole subject of friction and lubrication is marked by difference of opinion and doubt.

Without dwelling longer upon the need of further investigation, engineers will generally concur in the opinion that in all branches of mechanical engineering and in many lines of civil engineering there remain far too many open questions to be answered, not by reference to fixed rules of practice, but according to the best judgment of the individual engineer.

Not only a system of organized investigation is needed, but a recognized, authoritative, permanent method of arbitration whose decisions shall be in the nature of those rendered by a highest court and

rank first in the minds of the engineering world. In other words, a perfectly equipped and systematized working bureau of engineering data is needed, whose functions should embrace the examination, affirmation, or negation of existing data, going over the entire field and instituting investigation for the purpose of supplying such additional facts and materials as may be found valuable in their application to practice. Could this be effected, long strides toward uniformity in practice would be made in a few years. Such an institution could very properly demand and receive the necessary funds for its foundation and support from the State. It would very much more than return its cost to the commercial interests of any industrial nation that might initiate it. But, as the results of such work could not be confined to the commerce of any single country, the institution ought to be international.

The world has lately been dazzled by the more than princely gifts of Andrew Carnegie for the founding of public institutions. This gentleman has acquired a collossal fortune in the prosecution of industries whose very existence, as well as marvellous development, is directly dependent upon the engineering arts. Since this development has benefited the nation as much as it has the philanthropic and generous organizer, no one could justly cavil were he to retain in his own possession the vast wealth he has acquired; but as he has announced his intention of distributing his fortune for the public benefit, during his lifetime, it may well be suggested that the foundation and endowment of such an institution as is herein proposed (without any disparagement, but rather with warm approval of what he has already done) would be of far greater and more universal benefit. An international bureau of engineering data would be a powerful educational influence throughout the entire civilized world.

That most likely to impair or defeat the usefulness of such a bureau is lack of adequate appreciation of its needs, and of the cost of supplying them in its initiation, together with ample provision for its efficient conduct for an indefinite period. If the views regarding the present condition of data available to engineering arts expressed in this article are correct, satisfactory approximation to uniform standard formulæ will be the work of years; and as engineering develops on new lines, as, for example, electrical engineering has done during the last twenty-five years, new and reliable data will be required. The industrial history of the world indicates advance, not retreat. There is no reason to believe that the century just begun will prove in this respect any exception to its predecessor.

It may well be that any attempt at an impromptu enumeration of the apparatus of a complete outfit will fail to include important particulars, but a general outline may be hazarded.

First, the outfit should include an analytical and experimental chemical laboratory of the most complete character, the experimental work for metallurgic investigations to be conducted on a fairly large practical scale. To do this, a part of the laboratory should comprise a practical foundry with a fairly good-sized cupola and furnaces for alloys wherein metals can be mixed and fused in practical quantities, in the study of mixtures, after the chemical composition of each of the materials used for experiment has been accurately determined. Physical qualities of resulting mixtures should be exhaustively investigated in a testing laboratory provided with appliances of the most approved kinds for conducting tests of all kinds of materials used in the mechanical arts, or proposed for such use. The question of resistance to oxidation or corrosion by external influences should, of course, be referred back to the chemical laboratory, to which, also, the protection of materials from injury by chemical agencies would also be properly referred.

The testing-laboratory apparatus should be of a size or sizes such as may be needed to test data for materials used in actual manufacture, from a silk filament up to a main shaft of a steam engine or a large girder. In short, it should be capable of testing the strength of anything proposed for test.

An ample physical laboratory of the most comprehensive character should afford the necessary facilities for examination and reexamination of all questions in dispute with reference to physical conditions in the operation of motors and other machines, and the effects upon durability produced by physical changes as the result of continued use. These studies should be pursued with motors operating under actual conditions of service, favorable and unfavorable, and there should be no stint in the outfit. Funds should be available for the purchase, erection, and operation of any motor or machine of sufficient importance to be made a subject of study. Here the action of the walls of steam cylinders upon steam during induction, expansion, and exhaust, and the effect of clearance partly or wholly filled to initial pressure, and similar points in steam-engine practice yet in dispute, should be finally settled, as well as the displacement from the adiabatic of curves of actual expansion under a sufficient range of varying practical conditions. This laboratory should also contain apparatus for an elaborate and exhaustive study of friction at rest and

at different velocities of rubbing surfaces, of all lubricants, and of methods of applying them.

There should be a specially arranged and equipped laboratory for the study of practical hydraulics and another for pneumatics, in which a revision of the data in these departments should be made with the utmost refinement that can be applied in actual practice.

An electrical laboratory would be a *sine qua non,* and it should be fitted to deal with any possible question upon which electrical engineers now differ, or which may arise in future practice.

The bureau should have as complete a library of all works relating to engineering as can be collected.

Lastly, it should have a department of publication from which should issue periodical reports of all the work done, the methods employed, the considerations which influence the choice of methods, and the results attained, so that the work accomplished may be continuously exposed to criticism and discussion of the methods, results, and quantity performed.

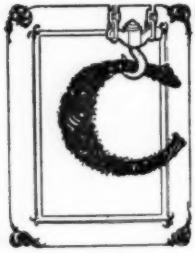
The usual methods of conducting the finances of large educational institutions would apply to an institution of this kind. The corps of investigators should be selected from men of the highest ability and they should receive salaries that would insure life service. They should be furnished with assistants in such numbers as the efficient work of the institution might demand, for the performance of such manual work as would be required. The buildings needed with the offices should not lack architectural fitness with proper regard for style in their ornamental features, and suitable consideration of site with relation to lines of freight traffic as a convenience in the handling of machines and materials in transportation to and from the institution.

Such an institution, located in any land, would produce the same excellent results; but the question of location, if it were founded and endowed as an international bureau, would probably give rise to prolonged debate. If, however, the munificence of some private individual should give it to the world, no difficulty of this sort would arise. He could select the country he wished thus to honor with a gift to the entire world, acquire a fame as lasting as that of Ptolemy, and erect a monument to the highest spirit of this wonderful age as remarkable, if not as durable, as the pyramids. Its value would be inestimable, and, as compared with current independent and sporadic investigations, its work—persistent, logical, and thorough—would command respect and bear an authority higher than any other on the facts with which it would concern itself.

THE DESIGN AND ACTION OF THE ROTARY CONVERTER.

By David B. Rushmore.

Electric power and apparatus for the utilisation of electric power have taken their place among the most useful agencies employed by mechanical and mining engineers, and with the opportunity to use these media comes the necessity for a general understanding of their nature and functions. It is to the useful work of explaining one of the most interesting pieces of intermediary electrical apparatus that Mr. Rushmore devotes himself in the following paper. A second article will discuss the operation of the converter.—The Editors.



CONTINUED extension of electricity to wider fields of usefulness brings also the necessity for better acquaintance, on the part of those not strictly electrical engineers, with the applications and properties of the various kinds of apparatus in which this form of energy is transformed and utilized. The understanding desired is not that presented in a popular form for the lay mind, nor is it of the purely theoretical character suited to those engaged in the design and manufacture of electrical machinery. It should rather be addressed to the buyer and the user. The mechanical or mining engineer has a given problem and he needs to know the facts which will help toward its solution. He is especially concerned with reliability of operation; with cost of installation, of operation, maintenance, and repair; with the depreciation, and with the danger to life. As a rule he is not especially concerned with any of the constants which enter into the design, unless it relates to the time element in operation. It is, however, not always possible to discover, under the usual conditions of commercial testing, just what the conditions of operation of a commutating machine will be, after it has been running for a considerable period of time. It is with the endeavor to bring before this class of professional and business men the principles of the rotary converter and the facts of interest in connection therewith that the present paper is written.

The areas of distribution from power stations have been increasing rapidly, and where it is desirable to utilize the electrical energy in the form of continuous currents the amount of copper necessary for satis-

factory operation has required so great an investment that a change in the method of transmission has been found expedient. One of the principal fields of application of continuous currents is to railway work. For some time the length of feeders did not in many cases exceed five miles and generation of continuous currents was best. When, owing to new developments or extensions of old lines, the distances from the power house were increased, boosters were introduced to raise the voltage on the long lines, and in some instances storage batteries were installed at the distant points. The storage batteries received power at moments of light load and kept up the voltage at times when heavy loads were thrown on the line. This solution gives a better station load curve, a higher efficiency, and more satisfactory electrical operation. But a limit in distance is soon reached here, and we come to the next and present solution—the use of the rotary converter in connection with alternating-current transmission. In some instances where most of the power is used within the prescribed radius, it is preferable to generate it in the form of continuous currents and to convert and transmit in the form of alternating currents only that part needed for the few outlying lines. In some stations what are known as double-current generators have been installed. These give electrical energy in the form of continuous and alternating current at the same time and in any desired proportion.

Large units of the capacity now specified for modern power houses are preferably made in the form of inductor or revolving-field alternators. These are cheaper to build, more easily repaired, less likely to get out of order, and should have longer life than large continuous-current generators. In many instances the necessary high voltage for transmission may be taken directly from the machine, and this is often done where the desired pressure does not exceed 12,000 volts. At a higher pressure, the necessary insulation for the armature conductors so reduces the output of the machine that transformers are placed between the generator and line, to step up the voltage to that desired for transmission. When it is considered that the cost of copper for the line varies inversely as the square of the voltage, it is seen at once how desirable it is to transmit the energy at as high a potential as possible. If the conductors are in the form of underground cables, the cost of necessary outside insulation increases rapidly with the voltage so that here a compromise must be effected.

When the energy is transmitted in the form of alternating currents, rotary-converter sub-stations are placed at intervals along the line, whence the power is distributed as continuous current.

Another field in which continuous currents are exclusively used is that of electrolytic work. While alternating currents may be used when heat alone is desired, continuous currents are necessary for electrolytic action. If all the power generated is to be used for this kind of work, it may be desirable to install continuous-current generators. Where, however, the load is of a mixed character, and a considerable portion may be used for transmission, the generation in the form of alternating currents and the use of the rotary converter offers the best solution. Rotary converters are also largely used in lighting work, in stations where it is desirable to run continuous-current generators in parallel with alternators, and in conjunction with alternating-current systems where it is desirable to use storage batteries.

The Rotary Converter:—Outwardly the mechanical appearance of a rotary converter is very much like that of a continuous-current generator to which has been added a set of collector rings. The use of the rotary converter (or simply "converter") is to transform electrical energy from the form of alternating currents to that of continuous currents or *vice versa*. In reality it may be considered to combine two separate functions, in which form it often appears, that of an alternating-current synchronous motor driving a continuous-current generator. In the converter there is but one field and one armature winding. The field does not differ materially from that of a continuous-current generator of the same frequency except in the proportion which it bears in size to the rest of the machine. The armature is usually of the parallel-wound type in which there are as many circuits as there are poles. The alternating-current leads are brought out at one end and the commutator connectors on the other. The commutator does not differ from the usual type otherwise than in containing more segments and in running at a higher peripheral velocity than is customary elsewhere. The collector is the same as would be used on an alternator. The commutator for a converter must be as large as for a continuous-current generator of the same speed and output. Owing to the absence of armature reaction under favorable conditions of working, and to the higher frequency at which the converter operates, the magnetic circuit of a converter should, if the machine be consistently designed, be small in comparison with that of a similar continuous-current machine. A machine designed for a continuous-current generator would probably make a good converter, but the reverse is not necessarily the case.

There is probably no machine extant today which is not the outgrowth of a considerable period of evolutionary action and the last of a variety of types. This is true of the converter. For more than half-

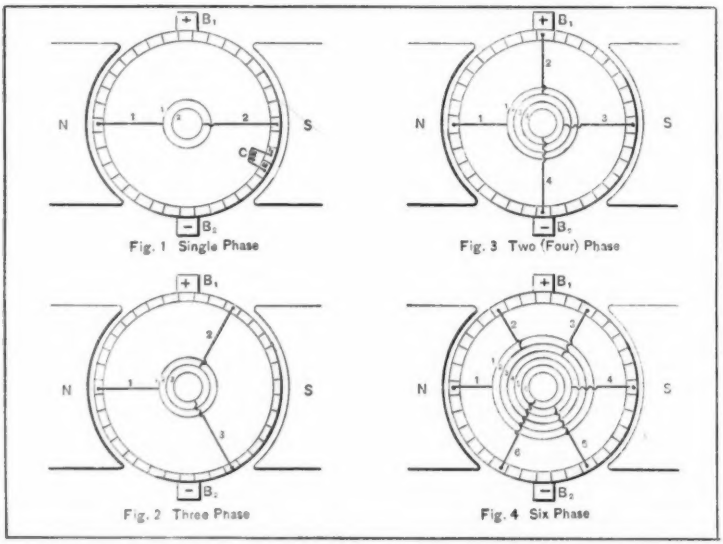
a-century there have been machines which converted alternating into continuous currents. Today there are many very interesting devices for this object, some of which may be developed into commercial form but at present are of interest only to those making a special study of the subject. The converter as above described is the only one at present in use on a large scale in the United States, and will be the only type here considered. In France, a type of revolving commutator having special transformers and a large number of collector rings has been developed. The high frequencies in use abroad have not been favorable to the development of converters.

If the commutator be removed and in its place another set of collector rings be substituted, the machine may be used as a phase converter. With further modifications it may be used to transform from one frequency to another.

Neutralization of Armature Currents and Heating. The individual peculiarity of the converter, which differentiates it from all other electrical apparatus, is the neutralization of currents in the armature conductors. The maximum potential of any alternating-current lead is reached when the commutator bar to which it is connected is passing under a brush. Its potential is zero when midway between the brushes, at unity power factor. Thus in the coils of a set the alternating and continuous current will part of the time be flowing in the same direction and part of the time in opposite directions. In the figures on the next page are shown diagramatically the connections commonly used for converters. The diagram represents a commutator between two field poles. To the proper points on the commutator are connected the alternating-current leads which run to their respective collector rings. The figures show two-pole machines, but these are simply the units of which machines of any size are constructed. In a four-pole converter everything except the collector rings would be duplicated, etc.

The names were given to the different systems before their relations were thoroughly understood. Thus the two-phase (so called) really comes between the three-phase and the six-phase. To be scientifically correct, the number of phases by which the machine or system is designated should be the number of alternating-current leads per pair of poles or 360 electrical degrees. We really have no single phase. What we call by that name is a two-phase. Then comes the three-phase, rightly named, after that the four-phase, misnamed two-phase or quarter-phase, and then the six-phase. As will be seen by comparing Figures 2 and 4, the six-phase consists of two interspersed three-phase systems and is taken from three transformers.

By an examination of Figure 1, we may obtain an idea of what occurs in the armature of a converter. The continuous-current brushes are designated as B_1 and B_2. Suppose the armature to be revolving anti-clockwise. At the position shown the alternating-current leads are midway between the brushes and the alternating electromotive force is zero. Also in this position the alternating current, supposing it to be in phase, is just reversing. As the lead 2 approaches brush B_1, the alternating electromotive force rises until when the alternating-current leads are directly under the brushes the maximum alternating-current



FIGURES 1 TO 4. CONNECTIONS USED FOR CONVERTERS.

voltage is equal to the continuous current voltage and in no case can it be higher. This is assuming that the machine is converting from continuous to alternating currents, which allows the explanation to be followed more easily. When the alternating-current leads are directly under the brushes the alternating current is a maximum, is equal to the continuous current in value, and flows directly through from commutator to collector without passing through the armature winding. Beyond this point the alternating current begins to decrease until when lead 2 occupies the position of lead 1 it again reaches zero.

To investigate what happens in the armature winding, let us take any coil as C. While the coil C is passing from B_2 to B_1, the continuous

current in the coil remains constant in value and in direction. When lead 2 is directly under brush B_2, before it has come to its present position, the continuous current, entering the armature at brush B_1 and flowing out at brush B_2, will flow through the coil C in the direction M to N. As lead 2 passes under brush B_2 the current flows directly through from commutator to collector, and as the current is flowing out at brush B_2 it must at that instant be flowing in through collector ring 2 and lead 2. As the alternating current is zero only at the position shown by the leads, either as numbered or reversed, the alternating current does not change in direction although it does in value between these two positions. So that just before lead 2 reached brush B_2 the alternating current was passing into the armature by lead 2 and out by lead 1. Thus alternating current flows into the armature by lead 2 during the time occupied in passing from the position of lead 1 to lead 2. The continuous current in a coil is constant in value and is reversed in direction when passing under the brushes. Thus while lead 2 is passing from position 1 to position 2, the alternating current flows through coil C in the direction N to M—that is, opposite to the continuous current—until coil C passes under brush B_2—and then in the same direction until position 2 is reached. Here the alternating current reverses, and the currents again flow in the same directions until coil C again passes under brush B_1. Hence it is seen that the instantaneous current in the armature conductors is sometimes the sum and sometimes the difference of the continuous and alternating currents. Coils occupying different positions with respect to the alternating-current leads, have different resultant currents and for different periods of time. As the heating is proportional to the square of the resultant current, the coils situated near the leads develop much more heat than those lying midway between. In this illustrative case the heat developed in the armature winding is greater than, for the same output, would be the case were the machine acting as a continuous-current generator. As the number of phases is increased the neutralization becomes more complete, until for a six-phase generator the permissible output from the standpoint of heat generated in the armature winding is nearly doubled.

If we consider the output of an armature as a continuous-current generator to be unity, the output for the same heating at unity power factor will be 0.85 as a single-phase converter, 0.97 as a split single-phase, 1.34 as three-phase, 1.64 as two-phase (four-phase), and 1.96 as six-phase.

Frequency. The element of frequency plays an important part

in the operation of rotary converters. The early frequencies used in the United States were 133 and 125 cycles per second. As the work done was almost entirely lighting and as the length of lines was not great, these gave satisfactory results. At such high periodicities generators regulate well—that is, give a small drop in pressure under load—transformers are small, and both arc and incandescent lamps work well. Parallel running of alternators, it is true, is not best obtained, but at the period of first introduction of the converter practically none of that was being done. When transmission lines became longer, the fall of pressure, which is greater at high frequencies, became too great and the periodicity of about 60 cycles per second was adopted. This is for many reasons well adapted to the operation of long-distance transmission, and is at present used for those California lines in which power is being transmitted more than 180 miles. The induction motor does not work well at high frequencies, and when the demand came for rotary converters another drop was taken to 25 cycles, which is common practice today for large installations where converters are to be used. For some installations it has been proposed to use from 8 to 12 cycles per second, but this has not been done in the United States. Elsewhere the frequency of 100 was for a long time used, and most of the alternators of European make exhibited at the recent Paris Exposition were built for 50 cycles. In the United States a number of plants have been installed using 40 cycles, and some 30 cycles. Standard American practice may be said to be the use of 60 and 25 cycles.

Converters are not commercially possible at 133 cycles. In cases which are especially favorable, such as water-wheel prime movers and a steady load, when worked in conjunction with storage batteries, they run well at 60 and 66 cycles. Under less favorable circumstances the operation may be satisfactory at these frequencies, but it is more uncertain. At 40 cycles they are to be trusted, and at 25 cycles they are a thoroughly reliable piece of apparatus. Being a commutating machine, it is only when we reach the frequencies of continuous current generators, which range from 8 to 25 cycles, that this function of the converter operates under normal conditions.

In order to illustrate the limitations of a converter, suppose we want to build one for 200 kilowatts, 133 cycles, and 600 volts, continuous current. The limiting conditions are allowable surface velocity and minimum width of commutator bar. A good value for commutator velocity at the periphery is 2,500 feet per minute. If now we sacrifice all we can in this respect and take the upper limit, which is

about 5,000 feet per minute, we shall at once see into what trouble we are at once led. We shall not be able to use more than twenty poles, which gives 800 revolutions per minute. This is somewhat immaterial as the width of commutator segment depends but little upon the speed because of the inverse change of the number of poles. With 5,000 feet per minute surface velocity and 800 revolutions per minute, the circumference of the commutator is 75 inches. The maximum difference of potential between bars will be assumed to be 20 volts, although this is too high a value. We need then thirty bars between adjacent brushes, and six hundred bars in the commutator. To get six hundred bars in a commutator 75 inches in circumference is manifestly impossible where the necessary insulation must be at least 1/32 of an inch of mica between bars. This is an exaggeration, but serves to illustrate the difficulty encountered in building converters for high frequencies. There are other features at the same point which do not conduce to satisfactory operation and which cause the machines to spark, hunt, and in general work badly.

Electromotive Forces. There being but one winding on the armature in which flow both the alternating and continuous currents, their electromotive forces stand in a definite ratio to each other. In alternating-current work we use an "effective" value for the electromotive force which is the square root of mean square of the instantaneous values. Then with equal maximum values the effective value depends upon the wave form. By varying the pole arc, the number of alternating-current leads, by changing the air gaps at different parts of the pole arc, and by concentrating or distributing the winding, we are able to vary the form of the generated electromotive force wave. In Figure 5 are shown characteristic wave forms. The second and third are only approximated in practice, while the first is frequently obtained. It is seen how great a variation may in this manner be produced in the effective values which are measured by a voltmeter, with equal maximum values. In single-phase and two-phase converters where the alternating-current leads of a phase are 180° apart the maximum instantaneous value is equal to the continuous electromotive force. Therefore the ratio of conversion depends upon the effective value. As before explained, this value varies with the proportion of various parts of the machine. With the usual form of distributed winding, the air gap is nearly constant over the entire pole arc and the wave form of electromotive force generated by each coil is practically rectangular. Owing to the distribution of the winding these are displaced from each other in regard to time. If we have twenty coils in a set between

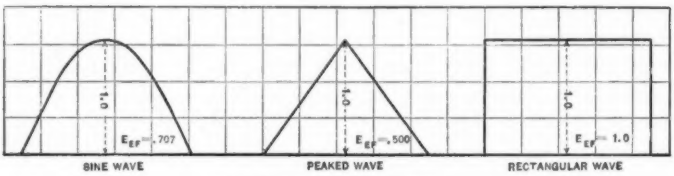


FIGURE 5. WAVE FORMS.

the alternating-current leads, each coil will generate a rectangular wave form, and these twenty similar rectangular forms, when added in series with the time displacement, produce a wave which is practically a sine curve like the first one shown. For most alternating-current working this is the desirable form. When one machine runs from another, which is the case where a converter is run from an alternating-current generator, it is desirable that both generator and converter give wave forms which closely approximate sine curves, and that these be not much distorted under load.

In Figure 1, when the alternating-current leads are directly under the continuous-current brushes the alternating electromotive force is a maximum, and is equal to the continuous-current electromotive force, neglecting a slight armature loss. The effective value of the alternating electromotive force then depends upon the wave form and the ratio of the square root of mean square value to the maximum. With a sine wave which is closely approximated in practice this ratio is $\frac{1}{\sqrt{2}}$ or .707. If we designate by E the continuous-current voltage, that between the collector ring and an assumed neutral will have one-half of this, or $\frac{E}{2\sqrt{2}}$, for an effective value. And to obtain the voltage between any two points on the armature we must combine these electromotive forces exactly as we should mechanical forces, using, however, angles of electrical displacement. In a two-pole machine the actual angle also represents the electrical one, and is therefore of convenience in assisting the understanding. In Figure 1 the alternating-current leads are shown 180 degrees apart. The electromotive force will then be the same in value and direction in these leads at an interval of half-a-cycle. As the two alternations which compose the cycle have equal instantaneous values at the same relative times, but are opposite in direction, the electromotive force between these two leads will be the sum of the individual values and will have an effective mean of .707 times the continuous electromotive force.

EDITORIAL COMMENT

THE place of the great professional society is one which is not always fully appreciated nor understood, and among the ill-informed there sometimes occurs a confusion of ideas which it is not always easy to set right. In the minds of some it is an organisation of which the usefulness is measured by the number of its members or the frequency of its meetings; others look to it as an elementary educational institution, in the sense of the uplifting of the masses, or the provision of opportunities for material advancement, in the personal and limited sense.

It is because of these contracted views that there has arisen a curious opposition in certain quarters to the wise plans of the Council of the American Society of Mechanical Engineers for the broadening of its scope in the true professional sense, as distinguished from the limited usefulness which must accompany the continuance of the present methods of work.

Beyond all question, its true position as a national society belongs upon a far higher plane, and any efforts to oppose the plans of the administration cannot be considered as otherwise than detrimental and unadvised.

Such an organisation as the American Society of Mechanical Engineers cannot stand still; it must progress, and its advance must be upward as well as forward; it must take its place beside the older institutions of Great Britain. Such an advance does not mean an accelerated increase in membership; rather must its growth in that direction be looked upon as necessarily becoming slower and slower, as the eminent engineers of the country are included in its numbers. The real progress must appear in its contributions to knowledge, in the results of its work as evidenced by the fame of its members and the importance and magnitude of their work.

It is evident that such a line of progress means increased expenditure as compared with the slower increase in resources. The cost of the publication of transactions of increasing magnitude and importance, the equipment of research undertakings, the provision for a growing library and cabinets, the demands for more liberal accommodations—all these demand a proportional increase in income and entire freedom from financial restrictions.

When such a most reasonable provision is decided upon by the Council, in due accordance with the rules and long-observed practice of the society, there appears, we regret to see, in some quarters a short-sighted attempt to oppose such far-seeing plans, and to appeal to local and personal elements to hamper and hinder the obvious work which lies before the organisation.

It is greatly to be hoped that such mistaken efforts will not prevail, but that the sounder views of the great majority of the eminent engineers and scientific men who must always form the true strength of such a society will act to maintain the high standing of the organisation, and overrule the attempt to appeal to lower ideas and limited views.

American mechanical engineering today stands in the front rank of the entire world, and the representative organisation of American mechanical engineers cannot afford to be governed by the

penny-wise pound-foolish ideas that some would have adopted. Rather let its members rally to the moral and financial support of their Council, and take the stand which is theirs by right, and which can only be taken from them by the mistaken foolishness of a minority of judgment, if not of numbers of their membership.

* * *

THE acumen which leads the shrewd politician to find out which way the procession is headed, and then to get in front of it and cry, "Come on, boys!" seems to be lacking just now in the United States Congress. The "strong and influential men in the Senate and House," according to recent newspaper report, believe that there "ought to be no tariff legislation of any sort at the approaching session of Congress." Meantime the National Association of Manufacturers—once the very priesthood of high protection—is holding its "Reciprocity Convention" in Washington "to discuss the expediency and practicability of the broader application of the principle of commercial reciprocity as a means of expanding foreign markets for American products." And this lead, set by the very element in whose supposed interest the high-tariff religion has always been preached, is followed by boards of trade all over the United States.

But the politicians have not yet waked up. The last thing they heard was "high tariff," and they go on, like Alice's Dormouse, singing in their sleep. "*Twinkle, Twinkle, Twinkle, Twinkle*—" said the Dormouse, "and went on so long that they had to pinch it to make it stop." The "strong and influential men in the Senate and House," if they still dream there should be "no tariff legislation," are very near the point where they will be unpleasantly wakened to activity by their constituents. "'The Dormouse is asleep again,' said the Hatter, and he poured a little hot tea upon its nose."

THE trade in American anthracite for Germany, which Mr. Saward discusses elsewhere in this issue, is taking definite form, recent shipments of 7,000 tons being recorded. The anthracite business is of course a small matter compared with exports of bituminous coal, but even concerning these an unusually able commentator observes that "there is no opposition on the part of interests in Great Britain to the United States supplying Continental markets with coal." One might go further and say it is an enormous and most beneficial relief. The over-pressure upon British mines, while temporarily enabling a few coal owners to make unusual profits, imposes a disastrous burden on industries of vastly larger volume. If the United States can satisfy a portion of this outside demand, the restoration of normal prices and the longer conservation of British fuel supplies will benefit, first, the iron and steel trades; second, the entire volume of manufacturing industries dependent on coal; third, the railways, which would share with the manufactures of the country any advantage of reduced working expenses which might accrue to them by decreased cost of coal.

* * *

A LITTLE knowledge is sometimes a dangerous thing, according to the late Mr. Alexander Pope, and the truth of this observation is again brought home to us when we learn from the report of the American consul at St. Etienne that a new (?) boiler has been designed by M. Serpollet, capable of sustaining a pressure of 80 to 176 pounds per square inch. To this is added the astounding news that locomotives in France carry ordinarily pressures of 35 to 39 pounds! Upon examination we find that the invaluable consul has simply converted kilogrammes to pounds, overlooking the fact that in France pressures are measured upon the square centimetre and not the square inch. His figures are about one-sixth large enough.

REVIEW OF THE BRITISH PRESS

The Gas-Engine Research Report.

THE presentation of the second report of the gas-engine research committee of the Institution of Mechanical Engineers is to be welcomed as an important contribution to the literature of a branch of engineering which is of growing importance, and no excuse is needed for discussing it at some length in this place.

The first report, which was presented to the Institution early in 1898, and which was reviewed in these columns in the issue of May of last year, was devoted mainly to a description of the engine and apparatus, with an account of some of the preliminary testing work, and the present report goes very fully into the work which has been accomplished since that time.

The actual testing has been done almost entirely by Professor F. W. Burstall, under the advice and suggestion of the chairman of the committee, Dr. Kennedy, and the methods and execution of the work demand most hearty commendation, especially as regards the valuable and original work in the determination of temperatures.

The engine, which is a small one, especially constructed for the work by Messrs. Fielding & Platt, is of 6 inches bore and 12 inches stroke; and running at 200 revolutions, it generates about 5 horse power indicated. The small size is somewhat against it as an origin of data for theoretical deductions, but the care which has been given to the work upon the trials, renders this objection a minor one.

In the present report some account is given of improvements which have been made in the engine, especially in the electric ignition, which had given some trouble. Experience with high-tension sparking had shown the difficulty of maintaining satisfactory insulation, and a new igniter, using a low potential circuit containing iron, was substituted. By using four storage cells, having a capacity of 50 ampere-hours, a short, thick spark was obtained which has never failed to fire the charge during a constant use of more than two years.

The improved indicator connection is also described, and by the use of an oscillating quadrant, with steel-tape connection, and with steel-wires running to the indicator, all error in the transfer of the piston motion to the indicator cylinder was eliminated.

The system which was followed in making the experiments was to work on four compressions: about 55 lb. per square inch, 71 lb. per square inch, 93 lb. per square inch, and 124 lb. per square inch, the pressures being absolute. The speed was kept the same for the whole of the tests, that is, about 200 revolutions per minute; in all cases the load on the brake was adjusted so as to make the number of explosions missed as small as possible. Experiments on gas engines when a considerable number of explosions are missed give rise to such varying ratios of air to gas as to render them useless from a research point of view; this is due to the fact that when a blank charge of air is drawn in, the residue in the clearance space is more than usually diluted with air, and the indicator diagram following the blank charge is not the same shape as those which follow an explosion. The tests under any of the compressions are given in the order of the ratio of air to gas. The series starts with very nearly the theoretical amount of air which is required to burn the gas, and then the tests are separated by, roughly, changes of 1 per cent. in the carbonic acid as found in the exhaust gases.

All volumes, both air and gas, are reduced to standard conditions, that is, a temperature of 15 deg. Cent. and a pressure of 760 millimetres of mercury; results are given in the metric system, but for the convenience of comparison a few leading

figures have been given in the English units also; limits of space prevent the adoption of the dual system throughout.

The ratio of air to gas has generally been found by assuming that at the end of the suction stroke the cylinder is filled with only air and gas; if the temperature of the mixture be assumed, the volume of air can be calculated from the ordinary gaseous laws.

This method is certainly not correct, as there is always in the clearance space a volume of the products of combustion which have been left over from the previous explosion stroke; the temperature of the mixed air and gas has been generally taken as not differing greatly from the jacket temperature, an assumption which is not in general borne out by the present experiments. If an accurate analysis of the exhaust gases can be made, it is possible to find the ratio of air to gas in a somewhat similar manner as in boiler tests, where the weight of air per pound of coal is found from the analyses of the flue gases and coal.

For any given mixture of air and gas it is possible to compute the temperature, this computation involving the measurement of the air drawn in during the suction stroke, and the composition and volume of the air and burnt products filling the clearance space after the exhaust valve has closed and a new stroke is about to commence. The method of these computations is given in detail in the paper, and the results are plotted in a curve for comparison with the experimental determinations.

In collecting the data for the preparation of a heat balance, Professor Burstall has taken into account the variable specific heat, and gives the formulas for its computation. If constant specific heat be adopted it will be found that during expension there is an apparent gain of heat instead of a loss to the walls, but if the hypothesis of a variable specific heat be adopted there is in almost all cases heat lost to the walls. By drawing adiabatic curves upon the diagrams, and comparing the temperatures and pressures, Professor Burstall shows that the experiments prove that the expansion curve should be nearly an adiabatic if maximum economy is to be attained, and that all the heat should be added at maximum temperature, and that any after burning is detrimental. Thus these tests fully support the theory of Diesel on both of these important points.

Reference has been made to the temperature tests, which are of the utmost importance and value. For this purpose the electrical-resistance pyrometer of Professor Callendar was used, and a very detailed account of the manner in which the pyrometer was applied is given in the original paper. Great care was taken to insure that the wire actually followed the temperatures to be measured, the temperatures being taken in the central clearance space, which would naturally be the hottest part. The results are tabulated in their proper place in connection with the other data and results, but it may be interesting to note that the maximum was very nearly 2,000° C.

The heat balances of the various trials are worked out very fully, and the manner in which the entire research has been recorded will enable the data to be used as most valuable additions to the practical study of the thermodynamics of internal combustion motors.

The thermal efficiency of the engine, using illuminating gas with a calorific value of about 5 calories per litre, varied from 17 per cent. at the lower compression, to 23 per cent. for the higher compression, the efficiency being based on indicated horse power; the mechanical efficiency of the engine being about 75 per cent.

The computations and results of the tests are given in the metric system throughout, with the conversion of a few of the more important quantities into English units. This may offer some inconvenience to readers, but enables the results to be readily compared with similar researches made in France and Germany.

Feed-Water Purification.

THE information prepared for the use of the Manchester Steam Users' Association often contains much that is valuable to the engineering profession at large, and the data issued by the chief engineer of the association, Mr. C. E. Stromeyer, concerning the purification of feed water and published in *Engineering* demand attention.

It is now very generally understood

that it is much more desirable to remove impurities from feed water before it enters the boiler than afterwards, especially if it is at all liable to form hard scale. There is but one way to prevent the formation of scale, and that is to be treating the water before it is fed into the boiler, so that apart from questions of safety, the matter is resolved into a comparison of the cost of purifying the water as compared with that of cleaning the boiler.

Assuming the cost of scaling and cleaning at 30 shillings per boiler, Mr. Stromeyer tabulates the annual cost of maintaining a boiler under various conditions of foulness, including an estimate of the probable lifetime of a boiler under the various conditions. The probable ages of boilers are based on the assumption that the gradual accumulation of scale during the time that each boiler is allowed to run will increase the wear and tear, and also on the boilers get little rest they will not be so well scaled as in others.

The annual cost, chiefly interest for a boiler using pure water with only such chemicals as are necessary to prevent corrosion, is about £35, while boilers using fact that in those installations where the sedimentary waters would cost from £37 to £75. If, then it can be shown that the interest, depreciation, and working expenses of a water-softening apparatus per boiler amounts to less than these extra expenses, the advantage in connection with very sedimentary waters is demonstrated.

Mr. Stromeyer gives a summary concerning fifteen water softeners which need not here be discussed in detail, but some of the more conspicuous features may be mentioned.

The principle of water-softening is very simple. The temporary hardness, caused by dissolved carbonate of lime and magnesia, is removed by the addition of a certain quantity of burnt lime, this causing precipitation to occur. The permanent hardness is removed by the addition of carbonate of soda, this causing further precipitation. The practical difficulties are found in the separation of the precipitates. The precipitate caused by the carbonate of lime especially, is very slow in forming, so that it is necessary either to use very large settling tanks, or else to devise some method of filtering, and it is in the perfection of details for this portion of the separation that the various differences in the devices on the market are found.

One of the practical difficulties which has been met in the use of purification devices has been the failure of the user to adhere to the instructions of manufacturers. In one case cited, it was found that double the proper quantity of lime was being added, thus rendering the water harder than before it was treated. In another instance the settling tanks had never been emptied, but had become filled with sediment, which had grown as hard as rock. When it is understood that water softening devices are intended to be intrusted to the tender cares of firemen, it will be seen that the utmost simplicity should be secured both in construction and in handling.

The various improvements in the process are divided into several classes. The treated water may be mixed with old sediment, as it is found that this, in again settling, carries down much of the new precipitate with it. Mechanical devices for stirring, or the use of air jets, may be resorted to to accelerate the precipitation or the water may be heated. These methods all have their advantages and disadvantages, but Mr. Stromeyer describes each in detail and leaves the user to decide which is best adapted for his service.

Some water-softeners work continuously; others are so arranged that a tankful is prepared at a time. When the latter method is adopted there is no difficulty in adding the proper quantity of chemicals, but with the continuous devices some special method must be employed, and many ingenious methods have been suggested. In some softeners the flow depends on the size of nozzles, in others on the difference of density, and in others, again, small measured quantities are tipped into the feed by mechanical means. Probably the old arrangement of using adjustable pumps is the cheapest and most reliable.

If the proper attention is given to cleaning there is no method which is so effective in purifying feed water as the use of heat, and much of the scale can be prevented simply by using the heat of exhaust steam to raise the temperature of the feed water to about 210° F., and providing space and

time for the precipitated carbonates to settle. If sulphates are present the addition of a small quantity of live steam is necessary, to raise the temperature above the boiling point, but the heat taken from the boiler in this way is nearly all returned to it with the feed water and but little loss follows.

The main thing to be emphasised is the importance of doing whatever needs to be done to the water before it enters the boiler, instead of putting any chemical into the boiler itself. If Mr. Stromeyer's recommendations do nothing more than make this point understood and practiced by steam users, his paper will prove a most valuable addition to the literature of steam engineering.

Superheated Steam.

Among the interesting papers presented at the mechanical engineering section of the Glasgow Congress may be noted that of Mr. R. Lenke, upon the use of highly superheated steam in engines, and some extracts are here given as worthy of practical attention and thought.

Saturated steam, or steam which has exactly the temperature due to its pressure, has aptly been described as steam saturated with heat, and the chief peculiarity which it possesses is that the slightest abstraction of heat is followed by a corresponding condensation.

"Superheated steam is generated by the addition of heat to saturated steam. The behavior of superheated steam is similar to that of gases; it is a very bad conductor of heat, and has the special peculiarity of being able to lose a certain amount of heat without becoming saturated or wet steam. The thermal capacity of steam is only 0.48, therefore very little heat is required to superheat steam; but as the steam loses the heat as quickly as it acquires it, every passage conveying superheated steam must be well covered with nonconducting material. Although there are some losses when using superheated steam on account of the heat radiation, they are very much smaller, because the loss of heat from superheated steam has lower calorific value than the latent heat of saturated steam."

The question of the cost of the additional heat is sometimes raised, but it can be shown that less heat is required to produce a cubic foot of superheated steam than to generate a cubic foot of saturated steam of the same pressure.

"The economy effected by using superheated steam in engines is very remarkable, and, acknowledging this fact, a great number of steam users all over the world superheat the steam, although in many cases only a few degrees, yet a considerable saving in steam and coal is always the result. To obtain the full benefit the required temperature of steam is 660 to 700 degrees F., and to stand this temperature the engines must be specially designed. It is not suincient to use mineral oil with a very high flash point, and any one who tries to supply an existing engine of any kind with steam at that temperature will have a very unpleasant experience, even when using the above mentioned oil.

"The introduction of superheated steam into engines largely influences the expansion of the heated parts. Engines always gave great trouble when the distribution of metal in the cylinders was not uniform, as parts with more metal expanded most and forced the cylinder walls toward the inside and made the cylinder out of shape. When using liners in the cylinders they were squeezed in at the ends, decreasing the diameter and jamming the piston body if sufficient clearance was not provided. With steam jackets heated with steam of 500 degrees F. the lubrication ceased as the cylinder walls became too much heated, consequently it was found necessary to do away with jackets, or if jackets were already provided, not to pass steam through them. Pistons constructed on the Ramsbottom type always work satisfactorily, except in the case of pistons fitted with steel springs, when they are in contact with highly superheated steam. Any kind of gun metal gets brittle after a very short time, therefore valves, seats and all parts in direct contact with superheated steam must be made of cast iron or other suitable mixture. Copper also loses about 40 per cent. of its strength at that temperature, consequently copper bends in pipes are not practicable. The best material for piping has proved to be wrought iron and steel, each pipe being as long as possible, to have the least number of flanges. For long

straight pipe connections provision must be made to meet the expansion, which is, at 700 degrees F., 0.037 of the length, so that, for example, 100 feet of pipe extends 0.37 foot, or nearly 4½ inches."

One of the most troublesome effects of expansion is found in the action of the steam valves. Slide valves and Corliss valves are naturally affected by the high temperatures, 480 to 500 degrees being the upper limit for the latter. Piston valves, when carefully constructed and proportioned, answer well, but they must be made especially for the service, or they will not answer. The longitudinal expansion of the cylinder tends to deform the steam chest and valve-seat, and provision must be made for such effects. Rings and springs in valves are objectionable, as it is difficult to keep the steam from getting between the rings and creating increased pressure and friction. Poppet valves have been used with much success, notably in the Schmidt engine, but care must be taken that the spindles do not stick.

"Besides the economy the use of highly superheated steam has some other advantages which are also important. It makes the steam consumption nearly independent of the size of engine, as a small engine has about the same steam consumption as a large one, as for example: An 80 horse-power compound condensing engine uses 10.45 pounds of steam at 160 pounds pressure and a 1000 horse-power engine uses 9 pounds of steam per indicated horse-power per hour. The use of highly superheated steam does not require high boiler pressures; 160 pounds is the highest to be recommended, as no advantage can be derived by exceeding this. As the amount of heat transmitted from the steam to cylinder walls, and *vice versa,* is much lower with superheated steam than with saturated steam, the whole range of temperature from boiler pressure to vacuum can take place in one or two cylinders, so that the use of a triple expansion engine does not make the slightest improvement in economy. It is not intended to be understood that the author proposes to do away with all triple expansion engines; for very large plants their use will be necessary for constructive reasons.

"Superheated steam engines use on an average 30 to 40 per cent. less steam than saturated steam engines of the same type. Consequently boilers can be made 30 per cent. smaller, and the difference in price will nearly cover the cost of the superheater. For the same steam consumption the superheated steam engine is cheaper, as it may be worked with a lower boiler pressure, and it is simpler—*i. e.,* instead of a compound engine with saturated steam, a single cylinder engine with superheated steam may be used, giving the same or better results than the former.

"In view of the great advantages of steam superheating, and the great number of engines running at present satisfactorily, it is astonishing that a few failures have caused prejudices among some engineers, who make the general introduction of the use of superheated steam very difficult. It will be worth mentioning that the results of a great number of trials have always proved a great saving in steam and coal, and even with small plants and simple piston valve engines almost the same good economy is obtainable as with large engines with most exact valve gears. It is therefore recommended that superheated steam should be used in connection with all engines; the only question to be settled is the degree of superheat, which largely depends on local circumstances and the construction of the engine, and this matter should be left to the judgment of an experienced engineer."

Variations in Electrical Conductivity.

It is generally understood that the fundamental principle employed in space telegraphy is the manner in which small metallic particles have their electrical conductivity increased under the influence of magnetic waves. The coherer, which in its present form is generally admitted to be due to Branly, consists of a small glass tube containing such metallic particles, and when this tube, forming a part of an electric telegraphic circuit, is exposed to the action of a magnetic wave, the particles cohere and the current is permitted to flow.

The very thorough study which has been given to this curious action by Professor Jagadis Chunder Bose, renders his paper before the British Association a very important contribution to this branch of electrophysics, and a brief abstract is of interest.

The behaviour of the particles in a coherer is generally assumed to be that which is indicated by its name, i. e., that the particles necessarily unite and have their conductivity somehow increased by their sticking together, this idea being further conveyed by the knowledge that in practical systems of space telegraphy the coherer must be tapped to effect decoherence after it has been acted upon by a magnetic wave.

As a matter of observation, however, various effects may be produced by magnetic waves, and there really appears to be some sort of a molecular change produced, the nature of which is by no means clear.

We know that the physical properties of a given substance depend on its molecular condition, and it is but reasonable to expect that any molecular change should be accompanied by physical changes, among which conductivity is included. The wide difference in electric conductivity of the same substance under different molecular conditions is seen in the case of carbon, in its two allotropic forms of graphite and diamond. That radiation is effective in producing allotropic changes is seen in the conversion of the yellow into the red variety of phosphorous under the action of light.

Instead of the mere production of conductivity, it is found that this is but one effect which may be produced by magnetic waves. As pointed out in a previous paper by Professor Chunder Bose, substances may be classified with regard to their sensitiveness to electric radiation into three types, positive, negative, and neutral, differentiated by the characteristic curves of variation of current with electromotive force.

In order to study the whole subject from this broad standpoint the author made a number of experiments with a most interesting apparatus which he terms a curvograph. Previous experiments had been made by subjecting particles in a tube to variations of electromotive force by the use of a potentiometer arranged with a sliding contact; the position of the slider and the deflection of the galvanometer giving points in a curve. The practical difficulties which were encountered with this apparatus led to the construction of an automatic recording device, based upon the same principle. The galvanometer was replaced by a reflecting mirror instrument, and the spot of light was reflected downward by a fixed mirror, so that it was thrown upon the surface of a horizontal platform. This platform was connected with the sliding portion of the potentiometer, and bore upon its upper surface a sheet of sensitive photographic paper. The compound motion of the sliding platform and the galvanometer mirror caused a curve to be traced upon the paper, such a curve being characteristic of the materials under examination. It is impracticable to go into the discussion of the results of the experiments in this place, but in the paper of Professor Chunder Bose, which is reprinted in full in *The Electrician,* copies of numerous curves are given and their exhibition of the behaviour of the substances examined is discussed. Briefly the conclusions are that the changes in conductivity which appear are not chemical, but appear to be molecular. The conduction does not obey Ohm's law, but varies with the electromotive force, instead of being independent of it. Certain substances have their conductivity changed under the stress of electric radiation, but recover as soon as the stress is removed, thus exhibiting a close analogy to a mechanical stress within the elastic limit.

These and a number of other properties are revealed by the curves drawn by this ingenious apparatus, and since we are promised further accounts of later experiments, we cannot but anticipate revelations which may materially change accepted notions concerning electric radiations in general, as well as the manner of their action in space telegraphy in particular.

Railway Goods Traffic.

MUCH has been said about the greater economies which are effected in the hauling of merchandise by American railways as compared with those of Great Britain, but so much unintelligent matter has been printed about it that it is refreshing to see the subject so well discussed as in a recent article in the *Engineer.*

Trains of 2,000 tons, and hauls of 1,500 miles may be economical in the United States, but there is hardly a place for them in Great Britain, while as to 50-ton cars, their use is hardly practicable without an entire reconstruction of all the handling machinery at the docks and elsewhere.

Improvements are undoubtedly possible in British methods, but they must be based upon British conditions, and not upon conditions which exist elsewhere and are physically impossible in England. The greatest opportunity for improvement lies in the reduction of idle wagons, and the maintenance of a higher degree of efficiency with the present equipment.

The great difficulty the railway companies have to contend with in dealing with mineral traffic arises from the merchants, iron masters, and colliery owners keeping the railway wagons loaded both in iron ore and coal districts until it suits their convenience to unload. A very large proportion of the coal moved is for small consumers of, say, one ton, and no provision is made for proper unloading and storage at the mineral depots. The railway companies and traders stand very much in their own light in this respect, when, in distances of only twenty miles they consider themselves well off when they get one to two runs a week out of their wagons.

It is unnecessary to multiply examples to show that the first place to effect economy lies not in increased sizes of wagons and trains, but in a more expeditious handling of existing facilities. This can be done entirely by better terminal and station management, together with the intelligent cooperation of customers and shippers, who should be aroused by the offer of lower charges to provide increased facilities of their own. Traders must be made to see that it is their interest to provide proper means for disposing of their goods or minerals rapidly and cheaply when they reach their destination if any improvement in the reduction of transport is to be effected.

In other words, more economical railway goods traffic is to be secured in Great Britain by British methods, adapted to British conditions, and not by the importing of methods from some other part of the world, and especially from a country where conditions are essentially different.

Factors of Safety.

It seems almost like heresy to attack the hoary institution of the factor of safety, but that is what Mr. Robert Henry Smith has done in his presidential address before the Civil and Mechanical Engineers' Society, and we must be thankful to him for it. He does not deliberately demand that the factor of safety be abandoned or that it be replaced by some other method of providing for the unknown elements in a computation, but he does demand that it be understood and applied intelligently.

"Factors of safety are ratios in which pieces are made stronger than is required by calculation, according to the theory of strength employed, in order to allow for various kinds of uncertainty as to the exact value of the data, and to allow also for corrosion and abrasion. Sometimes uncertainty arises from doubt as to the legitimacy and theoretic accuracy of the formula or mode of calculation employed. This element of uncertainty would not exist if the method of calculation agreed closely with a theory of whose completeness and accuracy we were quite sure. Many formulas are employed, however, in which niceties and difficulties of theory are confessedly, and indeed, very often deliberately, left out of consideration. Very often the calculation is made on the assumption of uniform distribution of stress over the section, when it is well known that the stress varies largely from side to side of the section. In sections through joints of all kinds in machinery such large deviation from uniformity exists—sometimes the maximum stress is three times the average. The theoretic estimates that have actually been made of this deviation are doubtful in respect of accuracy, and, in any case are very seldom made use of, or even known by the practical designer. In many sets of circumstances such as these, and occurring most largely in connection with machinery, a very considerable part of the "factor of safety" found to be necessary is evidently attributable to the wrongness of the theory, which is the base of the formula. In many cases the theory or formula is known to be wrong, or, at least, incomplete; but it is not known in what degree its results differ from the true results. In other cases the incorrectness of the formula is not suspected by the man who uses it. Whether or not this be so evidently depends upon the amount of scientific and practical education that the user has received in the colleges and in works. Here it might be well to note that none of us have as yet received so complete an edu-

cation that we can always feel quite reasonably secure against an error of judgment as to the absolute reliability of any particular theory. But the important point to notice is that in cases in which it is desirable to adopt a formula as the standard for the practice of a profession, that formula must of necessity base itself upon the knowledge possessed by the average member of the profession. Thus there will be inevitably applicable to such a formula a factor of safety which includes compensation for the average ignorance of the profession. This average ignorance may be so different in Germany, France, England, and America, that different formulas rule the practice of these different countries, and correspondingly different factors of safety may be quite proper in these different parts of the world. But there are numberless details of design not settled by any series of rules which it is incumbent to impose upon a whole profession or trade. Then comes in the greater or less accurate theoretical knowledge of the individual designer. If one man designs merely in proportion to the average stress, he must use a larger factor of safety than is properly used by a man who can, and takes the trouble to search out the variation of stress across the section and makes allowance for it in his theoretic calculation.

"Thus, probably, a part of the whole factor used is due to the doubtfulness or ascertained defectiveness of the theory embodied in the calculation, and the ratio representing compensation for this must vary very largely with a number of conditions which are external to the physical nature of the problem itself."

Shipping Subsidies.

AMONG the papers presented before the British Association, we may note one read before the Economic section by Dr. B. W. Ginsburg, dealing with the question of shipping subsidies, and while the general trend of the paper was somewhat beyond the scope of the work of the engineer it contained some very suggestive features.

Referring to the question of commercial cruisers, receiving subsidies as such, it appears that England possesses two ships of 22 knots' speed, the Campania and Lucania, and three of 20 knot, the Teutonic, Majestic, and Oceanic; while in Germany's list the five fastest ships range between 23½ and 21 knots. France has four 22-knot ships on her list and building, Russia has six 20-knot ships, the United States, two 21 and two 20-knot vessels.

Discussing the policy of building very fast liners, it appears that the Deutschland is about 15 per cent. larger than the Ivernia, but cost about 50 per cent. more. The German ship has a crew of 553 persons; the Cunarder has but 257. The indicated horse power of the Deutschland is given as 35,000; that of the Ivernia is 10,500. The Ivernia carries a huge cargo, as well as a fair number of passengers, and has been running steadily ever since she came out, while the Deutschland did not run between November and April.

A detailed discussion of the subsidies given by various countries to mail carriers and to mercantile cruisers forms a large part of Dr. Ginsburg's paper. In conclusion he says that at present Germany is England's most successful rival.

The encouragement she gives to ships is devised wisely, but on a liberal basis. Her development during the last ten years is most remarkable, but it should not be forgotten that her percentages of increase are calculated on a figure originally small. When it is seen how her two great lines have come triumphant out of serious difficulties, it would seem to be suggested that amalgamation in shipping might strengthen British hands. State aid in England cannot be expected for any industry; the genius of the people is against it. Without attempting to teach their business to shipping men it must be remembered that sometimes new adventures have to be carried on at a temporary loss, and it sometimes pays to give facilities which the actual trade does not warrant. It would almost seem that in certain branches of the shipping trade, at least, there has been no private company which saw its way to risking the initial loss to open up a new line, and so the State-aided foreigners has crept in. In other branches it is possible too much reliance had been placed in an old name and existing connections, whilst no attempt has been made to meet threatened opposition. It is certain that in any naval war England would severely feel the want of vessels like the Kaiser Wilhelm II. and the Deutschland.

The Drop-Testing of Metals.

For a long time it has been a matter of much importance to ascertain within reasonable limits the strength of metals used in construction, especially of iron and steel, and during the past few years great advances have been made in methods of testing and recording results. A recent paper in the *Bulletin de la Société d'Encouragement pour l'Industrie Nationale,* by M. Ch. Frémont, treats broadly of the study of the strength of materials, and especially of the usefulness of the drop test, and contains much matter of interest and importance.

As long ago as 1734 Swedenborg, in his *Traité du Fer,* states that it was the practice of Swedish and English iron merchants to test the quality of iron bars by noting their behaviour under blows, while Grignon, in 1775, states that the quality of a bar of iron could be determined by nicking it and then breaking it at the nick, and examining the nature of the fracture.

Although the drop test has been practiced for nearly two hundred years, the tension test is fully as old, having been used by Muschenbroek in 1722, his example being followed by such famous men as Perronet, Gauthey, Rondelet, Navier, etc., and as this form of test is able to provide a numerical statement of the resistance of a specimen upon which a factor of safety can be based, it has come into general use. Until recently the drop test has been looked upon merely as an auxiliary to the tension test, but it has of late been developed to especial advantage since the general use of steel has made some method of determining brittleness essential.

For a long time, however, it has been realised that a metal which might give an excellent result under the tension test, might also be readily fractured by a blow or shock, especially if any crack or surface defect had formed. A test piece which gave a high tension test, with ample elongation, often showed a sudden fracture when struck a sharp blow, after a slight nick had been made in the surface, which would have been fatal in a completed structure.

These facts evidently furnish an explanation of disasters otherwise mysterious, such as boiler explosions, the breakage of rails, axles, tires, etc., when previous tests of the materials under elongation had been altogether satisfactory.

Naturally the use of the drop test is suggested as a method of determining the resistance of a metal under such conditions, but the drop test possesses certain disadvantages. In the first place it is usually a qualitative, but not a quantitative test, and therefore comparisons between various tests have not been practicable. Also it has been recognised that unless the same conditions obtained in all tests no definite record could be made of value for future reference. M. Frémont shows also that the results are very different if a test bar is broken by a number of moderate blows applied consecutively, or by a single heavy blow. It is to remove these indefinite characteristics from the drop test that M. Frémont has devoted his efforts.

The first condition imposed by him is that a drop test should be made by a single blow producing rupture of the test piece. This condition demands that in every case the blow should be heavy enough and made with sufficient velocity to insure rupture. The earlier method was to prepare a number of similar test pieces from the same metal, and subject these to a series of drops of gradually increasing height, with but one drop to each piece, until one piece is broken. M. Frémont, however, has greatly simplified this method, besides adding to its accuracy, by devising a system for measuring the residual living force in the ram after the drop has ruptured the test piece; the difference then giving the resistance of the material. For the details of the device the reader must be referred to the original paper, but it may be briefly described as consisting of a sub-stage to the anvil, supported by

springs, and receiving the blow only after the rupture of the test piece. The test piece is nicked, and the ram carries a projection which strikes in the nick, thus effecting the rupture, after which the residual energy of the ram is received by the springs and recorded automatically. This recording apparatus is calibrated by drop trials made without any test piece in the machine, so that the computed results are verified experimentally, and may be determined in terms of height of drop.

The use of the apparatus is very simple, since the height to which the ram is lifted is controlled automatically, and all the attendant has to do is to place the previously prepared test piece on the anvil and wind the ram up until it drops. The weight of ram remains constant at 10 kilogrammes, and the height is uniformly four metres, so that it is only necessary to examine the recording apparatus to determine the residual energy to be subtracted, in order to determine the resistance of the specimen.

M. Frémont has decided, after numerous experiments, to use a standard test piece of rather small dimensions, being 10 millimetres wide, 8 millimetres thick, and 30 millimetres long. These dimensions permit specimens to be readily cut from boiler plates, plates for shipbuilding, and similar work, as well as of heavier parts, and experiments upon more than 10,000 specimens have convinced him that reliable results may be obtained from such pieces.

In order to make sure that the test gives the brittleness of the piece a nick is cut across the top of the test piece, this being made with a saw 1 millimetre thick. Tests have shown that the actual depth of the nick, within certain limits, is without appreciable effect upon the result, the figures being practically the same for depths of 1 and 2 millimetres.

Results of a number of tests are given in the paper, together with much interesting information showing the unreliability of tension tests alone for the determination of the suitability of a material for any service in which it may be subjected to shock.

The enormous importance of the subject is so apparent that we feel sure that such tests will soon be required in specifications for materials of construction in addition to the usual tests for tensile strength.

High-Speed Steam Locomotives.

As a result of the attempts to design an electric motor car which shall be capable of operation at a speed of 200 kilometres per hour, or about 125 miles, there has arisen a discussion as to the practicability of accomplishing such a velocity with steam locomotives. While such a result evidently depends as much upon the road-bed as upon the motive power, yet assuming like conditions as to permanent way for both electric and steam locomotives, it is altogether possible that the steam engine may equal the electric motor, even though the latter possesses the great advantage of freedom from reciprocating parts.

In a recent issue of *Glaser's Annalen*, Herr Rolf Sanzin discusses the essentials of a steam locomotive to make a speed of 200 kilometres, and some of his points are of general interest, apart from the question of the desirability of realizing such speeds.

As he rightly says, the most important detail of such a high-speed engine is the boiler, The greater the heating surface and grate, the greater the capacity for power and generation. At the same time it is important that the weight be kept within reasonable limits, and hence the efficiency of a boiler for such a service is to a great extent measured by the ratio of its power capacity to its weight. This point holds good for the rest of the locomotive as well, for although the machine must necessarily be a heavy one, it is essential that every pound shall represent useful operative machinery.

These conditions at once indicate the use of high steam pressures, superheating, multiple expansion, and all methods of increasing power without involving a proportional increase in weight.

Herr Sanzin gives details of the general proportions of such a steam locomotive as appears to meet the requirements of high speed, taking an engine of 60 tons weight for the locomotive and 40 tons for the tender, with motive power of 1,500 h. p. He is inclined to favour the forward bogie truck, and if it can be arranged to avoid taking too much weight from the driving wheels, he considers that a six-wheel truck might be advisable. For the drivers the arrangement of the well-known "Atlantic" type of American locomotive appears good, since this permits the use of a wide deep fire box without

interfering with the employment of driving wheels of large diameter. With this design it appears practicable to build an engine of 2,000 h. p. at a total weight of about 110 tons weight, allowing 35 tons for the tender, and the use of track tanks for replenishing the water supply.

There is no doubt that a large part of the problem of exceedingly high speeds depends upon the condition of the roadbed. Already steam locomotives are making runs at 140 to 150 kilometres per hour, and 180 kilometres has been attained for a brief spurt upon existing roads, so that it appears as if the 200 kilometres speed should be attainable without any material revolution in locomotive design.

The Berlin-Zossen line, upon which the experimental runs of the electric cars are being made, has been constructed especially for such speeds, and all the conditions of alignment, smoothness and stability have been considered and met. If such conditions are taken into account for steam railways, conditions which mean much straightening of curves, and removal of grades, the performances of existing locomotives would doubtless be improved, so far as speed is concerned.

In view of all this discussion about high speeds, it is pertinent to inquire into the existence of other conditions which might more readily be corrected, and which affect the real speed of transport to a large degree.

The real speed of transport is measured by the time which is required to deliver the passenger from his starting point to his destination, and the running speed of the train upon the road is but a single element in that undertaking. In very many instances the passenger is required to be at the railway station long before the actual starting time of the train, in order to avoid crowds, secure places, attend to luggage and do a number of things which must be done, but which are not now charged to the speed of the transport. Upon his arrival at the terminus he usually is deposited upon a platform many hundred yards from any local conveyance, amid crowds which interfere with his progress, and subjected to many delays.

As a result the actual time of his departure and arrival between his individual starting and stopping places may be divided into two portions, one made up of time consumed in getting from his own starting point to his seat in the train plus the time required after leaving it before reaching his destination, the other portion consisting of the actual time of the train upon the road. For journeys of moderate length, the former portion often equals, and even exceeds the latter.

It is altogether possible that many of these delays, incident to railway transport, and not included in railway running time, might be very materially reduced, at much less cost than would be involved in saving an equivalent amount of time upon the road. Greater facilities for ticket taking and luggage handling, would permit the passenger to defer his arrival at the station until a few minutes before the departure of the train, and yet be assured of immediate and competent attention, as well as certainty of a comfortable place in the train. Upon the arrival the use of traveling platforms would facilitate the clearing of trains and the delivery of passengers to the local cabs and tramways; luggage of all kinds b ing rapidly and carefully sent to the ultimate destinations. All these features would cost money, but much less money than the boring of tunnels to straighten curves, or the digging of cuttings to remove grades. The principal difficulty in saving time by such methods lies in the inertia of officials, and the unwillingness to change methods which appears to be inseparably connected with all great corporations which approach the governmental in their desire to have things remain as they are.

Engineering Laboratories.

It was not so very long ago that the general meaning conveyed by the word laboratory was exclusively that of a chemical laboratory, the idea of a department of scientific reasearch not having been sufficiently extended to other branches of work to permit the extension of the word to its full etymological meaning. At the present time we have physical laboratories, physiological laboratories, and finally mechanical laboratories, and the latter have become among the most important adjuncts of technical and scientific education.

In a recent issue of the *Zeitschrift des*

Vereines deutscher Ingenieure is given an account of one of the most recent and complete of these engineering laboratories, that of the Technical High School at Stuttgart, the description being prepared by Professor Bach, himself being known as one of the ablest technical instructors and original investigators in Germany. The present laboratory has grown up under his own supervision since his entrance upon the duties of professor in 1878, there being at that time nothing whatever in the shape of a department of practical experiment and research in existence at Stuttgart.

The general idea of the laboratory, as laid out by Professor Bach, was to permit original research upon two lines of engineering work; one covering investigations upon the strength and other properties of the materials of construction, and the other including researches upon motors of every sort, especially upon steam engines. With the aid of the *Württembergischen Bezirksverein*, the local section of the *Verein deutscher Ingenieure*, a laboratory was started in 1881, especially for the purpose of testing the strength of materials, and this has since developed to such an extent that the new buildings and plant now described, cover both branches very fully.

The location of the laboratory is an excellent one, the proximity to the Neckar canal permitting the use of an abundant supply of water for pumps and condensers, while the neighbourhood of the other buildings of the High School permits the use of the laboratory as a place of combined instruction and research.

The experimental steam engine is a four-cylinder triple-expansion engine, the cylinders being arranged horizontally in pairs, tandem, the cylinders being 250 millimetres in diameter for the high-pressure, and 400 millimetres for the intermediate and low-pressure cylinders, with a common stroke of 760 millimetres. The high-pressure cylinder is fitted with Corliss valves, and the remaining cylinders with poppett valves, and the four cylinders may be connected so as to provide simple, compound, or triple expansion, as desired, the power for the triple expansion arrangement being 100 h. p. The engine is arranged to be operated with steam superheated to 270° C., and the clearance and receiver volumes may be altered at will to enable experimental studies upon such variations to be made.

In addition to the experimental steam engine, the laboratory is equipped with a department for gas engines, including two experimental gas engines, a gas generator and apparatus for testing and measuring the gas, while in other rooms are steam pumps, and apparatus for researches in hydraulics. The boiler house is equipped not only with the steam generating plant for the laboratory, but also with appliances for boiler testing and for the study of fuels and firing.

It is not our intention, in calling attention to this recent laboratory, to enter into a detailed description of its equipment, but rather to use it is an occasion to discuss the great importance of technical laboratories in general. Formerly testing either of machines or of materials was conducted solely for commercial purposes, being intended either to maintain the standard of product, or to enforce the provisions of specifications and contracts. Such testing, while doubtless most useful, was rarely available for purposes of education or of original research, and the expense of systematic testing precluded its adoption in industrial establishments for other than the strictest commercial requirements.

With the advent of mechanical laboratories, however, there has been a general advance of the knowledge of the behaviour of materials and methods of use, and the whole status of the work of the constructing engineer has been raised by reason of the mass of original knowledge which has been acquired in these institutions.

Apart from the general educational value of such work, it is possible in the laboratory to investigate problems which have originated in practical work and have been referred to the student and the professor for further elucidation. In such matters the laboratory has proved a most valuable auxilliary to the work of the technical professional society, and much of the research work of committees of such bodies has been performed in the laboratories of institutions in which the active members have been instructors and professors.

One of the most valuable features of such work lies in the publicity which attends the researches, and not the least healthful in-

fluence exerted is the banishment of the spirit of secrecy and mystery which formerly surrounded all original work of investigation. When researches involving much expense are undertaken by private establishments there is a disposition to regard the results as something to be kept from competitors, and while this spirit can readily be understood it is none the less to be deplored as tending to retard the progress of the profession at large. The work of the engineering laboratory of the technical school, on the contrary, is made public, in the fullest sense, the apparatus being described and illustrated, and the results published and distributed far and wide, with most beneficial results. It is therefore a subject of congratulation to the profession of engineering at large to note the completion of such departments, and no department of engineering education is more worthy of encouragement and assistance.

Modern Methods of River Regulation.

ALTHOUGH the necessity for controlling and regulating streams has been a necessity almost from the beginning of civilization, it forms a branch of engineering which is probably as unsettled as any which might be named. The conditions are so varying that the practice of one locality necessarily differs from another, and hence the prevalence of empirical methods, and the absence of systematic and scientific study.

Of late years, however, the subject has been given more scientific consideration, and in a recent paper by Herr Ignaz Pollak, published in the *Zeitschrift des Oesterreichischen Ingenieur und Architekten Vereines*, the modern methods of river regulation are reviewed and discussed.

The rational treatment of river regulation appeared in a paper presented by M. H. Girardon, at the sixth international congress for internal waterways, held at The Hague in 1894. M. Girardon is a chief engineer of the department of Ponts et Chaussées, in charge of the special service of the Rhône and his views are the outcome of the experience gained in this work. This paper was followed by one presented at the eighth international navigation congress at Paris in 1900, by M. Timonoff, professor at the technical institute of St. Petersburg.

The general principle of the modern system is to regulate a river in the true sense of the term, and not to convert it into a canal.

In an unimproved stream all the elements are variable, including volume, slope, velocity, and nature of banks and bed. The earlier methods of regulation sought to render all these elements stable, and so far as possible to make them uniform. The idea was to straighten the channel, and to unify the slope as nearly as possible to its mean value, or at least to control successive sections in this manner and in general to transform the natural regimen of the stream.

The modern system on the contrary, seeks to study the stream in its natural state, to investigate the reasons for its serpentine path, and for the variations in depth, and to establish and maintain a navigable channel by assisting and reinforcing the natural course of the stream, instead of compelling it forcibly to assume a new one.

The winding course so generally found in unimproved streams is by no means accidental, but can in nearly every instance be referred to natural and local causes, which exist and persist in spite of any efforts to overcome them, and which can be enlisted in the work of maintaining a proper channel, if proper judgment is used. Attempts have been made to reduce the paths of river beds to mechanical and geometrical laws, but the conditions are too complicated, and the number of variables too great to enable a satisfactory solution of the problem to be made in this manner. Observation, however, has revealed certain facts, such as the erosion of the bank and bed on the convex side of a bend, determining to a certain extent the position and depth of channel, and the probable modifications of its course.

M. Timonoff reviews the methods of river regulation, as conceived and executed under the earlier ideas of engineers in in all parts of the world. These methods include a determination of a so-called "normal" cross section for the stream, and an attempt, by artificial structures to confine the water to a single channel approximating to this determination. Curves are supposed to be eliminated or modified so far as possible, and the banks protected by quays, levées, and similar works.

Opposed to these are the principles enun-

ciated by Girardon, and expanded by Timonoff. According to Girardon the stream should be guided and regulated in the course which it has already marked out for itself. The true aim of the improvement works should be to prevent the navigable channel from overrunning its natural depth, this to be kept in mind both in the construction of works upon the banks and upon the bed. Improvements for the control of high water flow should be most carefully planned so as to avoid interference with the course of the normal and low-water channel, since it is under the influence of floods and high waters that the greatest deformations have their origin.

The work of Timonoff is based largely upon results obtained in a study of the Volga, while that of Girardon, as already mentioned, is due to his experience in the regulation of the Rhône.

Recent German Shipbuilding.

THE series of able papers upon the development of shipbuilding in Germany, by Herr Haack, which appeared in the pages of this magazine in 1899, gave a general account of the manner in which this important industry has grown in Germany since 1870. That development has since been emphasised by the magnificent products of the Germany shipyards, and especially of the great Vulkan works at Stettin, which have been placed in commission and which have shown by their performances the thoroughness with which they have been designed and constructed.

The Deutschland has already been described and her record-breaking performances are well known. Now this great ship is followed by another from the same yards, and from an account in a recent issue of *Stahl und Eisen*, we abstract some notes about the Kronprinz Wilhelm, the latest triumph of German shipbuilding.

Built for the North German Lloyd, the Kronprinz Wilhelm exceeds her predecessor, the Kaiser Wilhelm der Grosse, both in dimensions and in speed. The new ship is 663 feet long as against 648 for the "Kaiser," the displacements being respectively 21,280 tons, and 20,380 tons. The vessel is divided into 24 water-tight compartments so arranged that any two, even if adjoining, may be entirely filled without danger to the ship. The doors of the compartments are arranged so that they may be closed at night or in time of fog, without seriously affecting the convenience of the passengers, while a system of electric indicators in the chart room shows the officer on watch the position of every compartment door, whether open or closed. The vessel is most completely equipped with electrical appliances of every kind, for lighting, heating, ventilation, and communication.

The propelling machinery consists of two sets of quadruple engines of six-cylinders each, counterbalanced on the Schlick system, and capable of developing 30,000 horse power, the nickel steel propeller shafts being 25 inches in diameter, steam being furnished by twelve double ended and four single ended Scotch boilers, operated at a pressure of 215 pounds per square inch.

Although no official announcement is made of attempts to break records, the fact that the Kronprinz Wilhelm and the Deutschland are in the hands of rival lines, and are the latest products of the same makers, there is every reason to believe that records will be lowered by them at least until another giant structure now under construction shall appear as a still later and greater rival.

Germany now possesses 13 express steamers of speeds between 19 and 24 knots, while the fast liners of the Cunard and White Star companies attain speeds of but 20 to 21 knots. There are also 22 vessels operated by German owners and built in Germany of a displacement exceeding 10,000 tons, while England at present possesses but 20 such vessels. These figures serve to show the growth of German shipbuilding, and the manner in which an industry almost wholly British but a few years ago has become also German.

The Electrical Manufacture of Glass.

THE process of manufacturing glass has undergone several important modifications within recent years, these changes appearing mainly in the methods and apparatus for fusing the mixture of silica and alkalies.

The pot furnace in which a number of clay pots are arranged within a furnace and acted upon externally by the heat from an adjacent grate, has largely given way to the so-called "tank" furnace, the glass being

fused in large quantities upon the hearth of a reverberatory furnace. With the introduction of the tank furnace the use of direct firing has been replaced by gas firing, and with this either regenerative or recuperative systems are employed.

The use of the electric furnace is now advocated for the purpose of glass making, and in a recent issue of the *Elektrochemische Zeitschrift* we note an article by Dr. Bermbach, describing the arrangement of furnace for the employment of electric arcs.

In the types of electric furnaces employed for the production of carborundum and calcium carbide, the operation is generally intermittent, a charge of material being placed in the furnace, the terminals adjusted, and the current turned on until the operation is completed, after which the mass is permitted to cool, and removed for a fresh run. Various attempts have been made to construct continuous electric furnaces, especially for the production of calcium carbide, but as yet these are not in commercial and practical service.

Since the temperature of fusion of the materials for glass making is much lower than that required for calcium carbide, or for carborundum, the problem of constructing a continuous furnace is materially simplified. Dr. Bermbach gives the general arrangement of such a furnace, showing how the crushed and mixed material is fed in a continuous stream, the fused glass being drawn off in like manner. The furnace contains three electric arcs, arranged in succession along an inclined plane, each arc having a sort of pocket below it in which the fused mass can collect and overflow to the next one. The crushed materials are fused between the terminals of the first arc, and are more thoroughly mixed in their passage to the second, while the final fusion in the third arc effects to production of the very fluid glass, which is delivered into a collecting pot from which it can be taken at once for manufacture of any desired articles.

It is well-known that when carbon electrodes are impregnated with various salts it is possible to obtain long arcs with currents of comparatively low pressure. In the use of arcs for fusing glass, therefore, the electrodes are prepared with solutions of soda, potash, sodium sulphate, etc., this enabling arcs of 2 to 3 centimetres long to be obtained with a pressure of about 40 volts, and with the arrangement of three arcs above described the current required is about 100 amperes for each of the first two, and 50 amperes for the third arc.

Melted glass is a good conductor, the conductivity varying somewhat for various kinds, and experiments are in progress to determine this point more exactly. Since the glass is electrolytically decomposed by a continuous current, it is necessary to employ alternating currents for the electric glass-furnace.

The important feature in connection with the process naturally lies in the cost, as compared with the older methods. This necessarily depends largely upon the cost of the electric current, but is also affected by the diminished size of the plant. Instead of a large tank, holding a great mass of molten glass, the electric furnace requires but a single pot, into which a small stream of fused glass is continually flowing, as water runs from a pipe, and much of the great expense of erecting and maintaining furnaces, regenerators, gas producers, etc., is avoided. Little or no time is lost in starting, since the great heat of the arc produces an immediate fusion of the powdered materials, and hence the operation may be started and stopped at any time, by the mere turning on or off of the electric current and the flow of material.

An interesting feature of the method appears in the fact that it renders glass-making possible in localities where the high price of fuel is prohibitory, but where water power is available for the generation of electricity.

The Optical Study of Metallic Surfaces.

We have noticed elsewhere the researches of M. Frémont upon the brittleness of steel and other metals, showing conclusively that tension tests alone are insufficient to permit the true strength of a metallic structure to be determined.

Supplementing these researches comes an important study by M. Vinsonneau, published in *Le Revue Technique*, extending the work of M. Frémont by showing the possibility of determining with a fair degree of accuracy the character of a piece of material by an optical examination of its surface.

This method appears to be especially applicable for the detection of molecular changes in a material after it has been in use for some time, and is beginning to feel the effects of the stresses to which it has been subjected.

M. Cornut has expressed very clearly the manner in which the molecular condition of a material may become changed by the application of external forces.

If we suppose a piece of steel or iron to be subjected to a continuous stress, slowly and gradually applied, it can readily be understood that such a persistent stress will be transmitted successively from molecule to molecule, in such a manner that all the molecules of the body will become subjected to the same stress. If, on the contrary, the stress is suddenly applied, we can understand that sufficient time is not given for the distribution of the stress, and hence the molecules which are first impressed may be disarranged before the stress can be transmitted to the others. It is therefore altogether possible that materials may be affected very differently when subjected to slow or to sudden stresses.

Now the experiments of Frémont have shown very clearly the manner in which a nick or break in the surface of a bar will permit it to break very readily under a blow if the metal is at all brittle. The narrower and sharper the nick the more readily will the rupture occur, while a smooth and shallow depression does not appreciably affect the strength.

It is naturally most important that pieces which are to be subjected to heavy or sudden stresses should be most carefully inspected at the time of their manufacture in order that any surface cracks may be detected. At the same time a piece may be entirely free from visible cracks and yet contain internal cracks which the effects of alternating stresses, or changes of temperature bring to the surface.

It is possible to see some such cracks by the unaided eye, but these are less dangerous than the minute indications of interruption of continuity which can only be revealed by a closer examination. The value of such optical inspection is more to be realised when the effects of high speeds are understood. Such pieces, as the crank, crank-pin, connecting-rod, and piston-rod of a steam engine may be entirely free from injury at moderate speeds, while at higher speeds the formation of cracks and liability to breakage is greatly increased.

The care with which the surfaces should be scrutinized necessarily depends much upon the character of the machine and its work. For the operative parts of a marine engine or of a dynamo, or a modern high-speed engine of large power a very careful scrutiny is desirable. The nature of the defects which may be revealed under a magnifying glass should convey valuable information to the experienced eye. Thus the fine lines, indicating incipient cracks, may be either longitudinal or transverse, while their form may also show where weakness or possible fracture may develop.

The importance of such indications naturally depends much upon the material in which they are seen. As M. Frémont has shown, a test piece may give high results under tension, while the drop test upon a nicked bar will reveal a high degree of brittleness. Such a material becomes uncertain with the slightest appearance of any surface cracks. With a material which has given a high result under the drop test, however, much more security may be felt. M. Vinsonneau gives an example of the examination of the tubes of a Belleville boiler in a case of a mysterious rupture. Here a careful inspection of the surfaces revealed cracks, produced probably by vibration and by expansion and contraction strains, rendering the metal altogether unreliable.

Other examples, such as the piston-rod of a steam hammer, and similar subjects exposed to shock and vibration are cited to show the entire feasibility of inspecting important pieces from time to time, and obtaining ample warning of coming fractures in time to prevent serious accidents.

In view of the rapid increase in speeds and pressures, and the general high-pressure system of working now becoming so general, it is evident that some method of systematic inspection should be adopted if full security is to be maintained. Such a system of optical inspection as suggested by M. Vinsonneau, preceded by careful testing for brittleness, as well as for tensile strength should enable materials to sustain with entire safety, stresses and speed which might otherwise be altogether uncertain.

Modern Naval Engineering.

In examining the report of Engineer-in-Chief Melville, of the United States Navy, we are impressed with the testimony which it offers to sustain a position which has already been emphasized in these columns; the necessity for a revolution in the control and handling of those fighting machines known as ships of war.

It was Captain John Ericsson, we believe, who first described a war ship as a fighting machine, and it was Ericsson's Monitor which first showed the naval powers that henceforth fighting on sea at least was to be done by machinery. The lesson is one which has been but slowly learned, notwithstanding the thoroughness with which all the skill of engineer and machinist has been impressed into the work of construction. The manner in which the fine fighting machines possessed by Spain were mismanaged at Santiago is negative testimony, at least of the uselessness of putting such vessels into the hands of any but engineers.

The enactment of the personnel bill for the United States Navy was intended to increase the efficiency of the engineering department of the service. At least that was the ostensible reason for its enactment. The real reason, as is well understood, was to put an end to the controversy between the line and the staff officers, and the act was intended to require all officers to be qualified both for the deck and the engine room.

As Mr. Melville clearly points out, the bill has failed of its purpose, simply because the great majority of the officers prefer the deck to the engine room, and because the act contained no provision for the alternation of duty between the two stations. The success of the personnel bill depended entirely upon the manner in which it was interpreted, and the controlling influence which made possible the passage of the bill was expressed by the then Assistant Secretary Roosevelt's statement: "Every officer on a modern war vessel has to be a fighting engineer."

The present is rightly regarded as an age of engineering. A modern battleship is a floating fort, filled with complex machines whose efficient care and maintenance should only be intrusted to a trained mechanical force, and the best efforts of this force can be obtained only when directed by trained officers.

It is not sufficient, however, to assume that trained engineer officers are needed in connection with the management of the propelling machinery only. They are really a necessity in every portion of the ship, and there is to-day practically no department in which a working knowledge of engineering is not required. Under these circumstances the personnel bill is all right; it needs only to be fully and determinedly executed. It will not do to introduce a number of warrant machinists to run the machinery, and to permit the men who have been educated at the expense of the government for the purpose of doing the work of the government to shirk their responsibility because, forsooth, they do not like engine room work.

Some day some one of the great naval powers will awaken to the fact that fighting by machinery means also fighting altogether with engineers, and by engineering methods alone, and will sweep the whole mediaeval system overboard, and equip a fleet with a grim lot of men in overalls, who will run a warship as if it were a machine shop. There will be no frills about uniform or rank or precedence, except so far as is necessary for organization and management; no disputing about credit or glory or any other ancient fiction. A warship will be an ugly piece of machinery built to kill men and smash things, and the men who do the work will do it for the wages they get just like any other workmen. The whole miserable business of warfare will appear in

all its ugliness, divested of all its glamor, as a horrible necessity, to be deplored if you like, but to be done mechanically and unimpassionately, just as Homestead rolls its rails and beams, and as Duquesne feeds its blast furnaces with ore and coke.

The nation which first attacks the war problem as a mechanical business, and turns it over, not to its Miles, and Corbins and Sampsons and Schleys, but to its Carnegies, its Morgans, its Fricks for managers, and to men like Corliss, Fritz, Baldwin, Jones, Hunt, Waring, Sweet,—engineers who know what to do and how to do it—that nation will have revolutionized warfare in the true sense, and made the great stride towards its abolition.

So long as fighting is considered a thing to be admired, to be associated with glory, popularity, social distinction, and personal adornment with uniforms and decorations, so long will it persist in all parts of the world as an honorable profession, to be the aim of many and the admiration of more. When, however, it is made entirely a mechanical performance, when the personality is taken out of it as wholly as in the case of modern automatic tools, when the identity of the performers in a conflict is as thoroughly concealed as it is now in every ordinary manufacturing operation, there will be fewer candidates for the training schools in the art of war, and fewer occasions for the exercise of the art itself.

Slag Cements.

THERE has been so much discussion as to the true commercial and industrial status of cements made from slag, that the paper of Professor W. K. Hatt upon tests of American slag cements, given in the *Proceedings of the Indiana Engineering Society*, is most welcome. In order to start right Professor Hatt proceeds to define the meaning of the term slag cement, as well as the present meaning of Portland cement.

A Portland cement, commonly so-called, is made from either pair of the following raw materials, sufficiently mixed together in a finely divided form:

Compact limestone with from 18 to 20 per cent. of clay;

Chalk and clay;

Marl and clay;

Clay bearing limestone properly dosed with clay or shale, and limestone. This mixture is calcined at a high temperature to nearly the point of fusion. The resultant clinker is ground to a fine powder, and in this condition called Portland cement.

Of late the attempts to utilize the slag produced by iron furnaces has led to its employment in the manufacture of cement. Limestone is used as a flux in the blast furnace, while the iron ore contains the silica and alumina corresponding to the clay elements in the Portland cement. The slag is suddenly cooled, in order to granulate it, after which it is dried and mixed with about one-fourth part of slaked lime, after which the mixture is finely ground to form cement.

"For works requiring an early and final strength, Portland cement is usually specified by the engineer. The attempt to use under such specifications certain cements, called Portland cements, but made from a mixture of slag sand and slaked lime, has led to a dispute. On one side we find ranged those who claim that an essential feature of production of a Portland cement is a calcination, or roasting of a certain artificial mixture of carbonated lime and clay to a clinker, and subsequent grinding to a powder. On the other side we find those who insist that the burning to a cinder of the limestone and other material of the blast furnace furnishes a material which, chemically, is nearly a proper mixture for a Portland cement, and that the subsequent correction by addition of a slaked lime paste does not, from the point of view of a definition, involve an error in the case of those who call this product Portland cement.

"There are two ways of regarding the dispute. First, from the point of view of a descriptive term it is well to have a separate name for the two products which are different in their mechanical and chemical properties. If we desire a sidewalk cement, we should not specify the material by any name which will involve a cement made by the second process above described for slag material, involving no calcination.

"Second. From the point of view of historic origin it has been pointed out that the original patent for Portland cement involved a double calcination; first of the limestone; then of the mixture of this cal-

cined limestone and clay. So, strictly speaking, our modern Portland cements have no right to succession to the term Portland.

"The cements made by the first process have, however, the right of possession to this term Portland. It would then seem the part of wisdom to divide the cements of this country into three classes—natural, Portland and slag.

"Natural will include those made by roasting and subsequent grinding of an argillaceous limestone (a natural mixture of limestone and clay).

"Portland will include those made by calcining to a clinker and then grinding an artificial mixture of the proper proportion of limestone (or marl or chalk, or clay-bearing limestone) and clay (or slag sand). The slag cements will include those made by grinding a mixture of pulverized granulated slag and slaked lime paste, which mixture has been made without applied heat.

"This matter is somewhat important, as at least four brands of slag cements as described above are on the market as Portland cements. To ask for a definite classification is not to find fault with slag cements. They have a distinct and high value for many engineering works. Let engineers write the specifications and manufacturers put out their product on the same nomenclature."

Since 1880 the progress of the manufacture of slag cements has rapidly advanced, and at the present time there are ten mills in France, twelve in Germany, and nineteen in other parts of Europe, as well as four in the United States.

The paper gives the results of a number of very careful tests made at Purdue University under the direction of Professor Hatt, these being fully tabulated and also plotted in graphical diagrams. The interested reader must be referred to these for details, but a few general features may be given here.

"The appearance of the slag cement is characterized by a delicate lilac color, in some cases almost white. When cement is made from slag by a process involving roasting, the cement is of a dark color like that of ordinary dark colored Portland.

"It has not the coarse or gritty feeling which characterizes most Portland cement. It works fast, sets slowly and passes ordinary tests for permanence of volume.

"A pat of the cement exposed to the air has to be well covered to prevent the surface from cracking. After drying out, it will exhibit discolorations, yellowish or brown, whereas the pat hardened under water will not exhibit such discolorations. The characteristic color of the fracture of a water-hardened briquette is green, but when the briquette dries out the fracture becomes white. The writer has noticed this green color, with a subsequent change to white, in the case of a well-known American Portland cement, and also the discolorations in the pat, indicating slag adulteration or else a not sufficiently oxidizing flame in the kiln. The green color is due to the presence in slag cement of sulphide of iron. This sulphide becomes oxidized on exposure to the air and changes color. Slag cements contain usually from 0.5 to 1.5 per cent. of sulphides.

"It is this tendency to oxidation on exposure to the air, which is destructive to mortar made of slag cements containing an excess of sulphides and makes it necessary to use the product in underground situations or the interior of thick walls. A parallel test of briquettes hardened in air and water should be made to check up presence of sulphides. This disintegration does not occur in case of all slag cements; it is not a necessary defect.

"Time of Set.—The European slag cements which set finally in six or eight hours seem to be more slowly setting than the American cements, which take their final set under the one-pound needle in from one to three hours.

Strength.—The mechanical strength of the slag cements under tension and compression is quite favorable, although not all equal to that of the better grade of Portland cements. The writer obtained for one of the best of these American slag cements a strength of somewhat above 550 pounds per square inch at the end of the year.

"In case of Portland cements, quick lime exists after burning and grinding; and air-slaking or aging is required. Often these Portland cements are sent out too new, the lime being masked temporarily by sulphate of lime. Since in case of slag cements the

lime is completely hydrated, no such danger exists of blowing or swelling, and they are said not to need any 'aging.' They are also said not to deteriorate on storage."

Slag cements evidently have their own proper place in engineering work, and their use should be encouraged whenever they are available, since they offer an excellent method of utilizing an otherwise waste product.

There need be no quibbling about names, since every engineer should specify a cement by its properties, not by name, and should require the standard he desires to be met by systematic and rigid tests, regardless of trade names or maker's reputations.

High-Frequency Electrical Oscillations.

In a very interesting address recently delivered before the Western Society of Engineers, and published in the *Journal* of the society, Mr. Arthur V. Abbott presented a good account of the effects of high-frequency electrical oscillations, and in a general way made some of the possibilities of high pressure oscillations clear.

After some general discussion of the nature of oscillations, exemplified by the pendulum of a clock, Mr. Abbott proceeds to show that in every electrical circuit there are four quantities which claim attention; first, the force present in the form of electricity, second, the resistance which is encountered in transporting the electricity from place to place; third, the electrical inertia, or inductance, the property which demands time for the transfer of electricity; fourth, the capacity of a circuit to contain an increasing amount of electricity with increasing pressure.

At every moment after a definite amount of electrical force has been impressed upon a circuit, it is found that the quantity of energy dissipated as heat, plus that stored in the magnetic field around the circuit, is exactly equal to the original quantity, and that if the electrical pressure be removed, the magnetic field and the capacity give up and restore the energy they have absorbed. This is a complete analogy to the original mechanical illustration of the pendulum.

After a number of lecture-room experiments to illustrate resistance, impedance, and capacity, Mr. Abbott proceeds to show some of their effects. In general it may be said that resistance acts to dissipate electrical energy, while inductance and capacity operate to store up and retain the energy in such a manner as to permit it to be subsequently recovered. Curiously also, inductance acts in a manner opposed to capacity. When a circuit is electrified, inductance acts in a manner opposed to motive force that opposes the transfer of electrical energy, while on the other hand capacity acts as an elastic electrical tank that courts an inrush of current.

Mr. Abbott describes an arrangement by which these properties may be utilized to produce electrical oscillations of high pressure and frequency, and with this apparatus some remarkable phenomena may be produced. Taking the 110 volt continuous current from the Edison service mains and passing it through a rotary transformer, an alternating current of the same voltage is obtained, and with a frequency of 133 periods per second. This current then goes to a static transformer, which raises the pressure to 10,000 volts. Across the leads from the transformer is placed a condenser, composed of sheets of tinfoil immersed in oil, and from the condenser the circuit passes to the primary of a high-frequency coil, being interrupted by a spark gap of five aluminum balls, this giving every opportunity for adjustment and variation.

This arrangement permits the production of discharges between the terminals of the high frequency coil with a pressure of about 200,000 volts, and a frequency of 178,000 to 616,000 per second.

The effects of such a system are similar to those of static electricity produced by the largest Holtz machine. With the very high frequency sparks no longer pass between the terminals, but instead each pole emits a violet brush which envelops it in a pale flame shooting a foot or more into the air. Sparks may be drawn to the finger with perfect safety, for owing to the high frequency there is no sensation. A glass plate placed between the terminals does not stop the sparks, as in the case of an ordinary induction coil; on the contrary there is a network of sparks spread over the surface of the plate, which is soon pierced. Many curious phenomena similar to nodes and loops of vibrating solids are produced, and vibrations may be set up in exhausted

tubes without the use of any connecting wires or terminals. The number of experiments and illustrations of the effects of such oscillations is unlimited, but they all go to give a deeper insight into the fundamental constitution of the universe than has been previously possible.

The atomic theory of Dalton assumed that matter was resolvable into a comparatively small number of different elements incapable of further analysis by any process. Physically each element could be reduced to particles of very minute yet perfectly appreciable dimensions, valled atoms, while an attempt to subdivide the atom would, if it could be conceived of as successfully result in its destruction at least in the material sense.

"Recently it has been shown that by electrically acting upon many of the elements in the gaseous state it is possible to split up the so-called atoms into portions that are from 1,000 to 2,000 times smaller than all preconceived ideas indicated possible. Such bodies have now received the name of corpuscles, and we are further confronted with good evidence that the corpuscles obtained by electrical analysis from different elements exhibit the same physical properties, or, in other words, that corpuscles obtained from hydrogen are the same in all respects as those obtained from oxygen. This leads to the very startling proposition that in an ultimate analysis there is only one kind of matter, and that the whole physical universe is but a vast phantasmagoria of Protean changes, wrought by one fundamental form of force, acting on a basic form of matter."

The Performance of Air Brakes.

THERE is probably no one more important factor in the improvement of railway speeds than the general introduction of modern continuous brakes. Those who remember the loss of time involved in the operation of the old-fashioned hand brakes realize this very fully, while a parellel to the old-time conditions for passenger trains has been found until recently in the handling of freight trains.

The present conditions in the practice of railway air brakes were well brought out in a paper recently presented before the New York Railroad Club by F. M. Nellis and some extracts will show the close relations of efficient air-brake performance to economical transportation.

Mr. Nellis affirms that the railways in the eastern states are behind those of the far west in air-brake maintenance, and urges the necessity for more thorough inspection.

"Should a close investigation be made of air-brake doings in testing and repair yards, roundhouses and shops, a large number of roads would find that their machine of air-brake practice and maintenance is working at very low efficiency. What is first and more needed than anything else, perhaps, is a candid recognition of the fact that the air-brakes in freight train service to-day are not receiving the attention they should.

"An honest appreciation of this condition, and an organized and systematic effort to better look after the road practice and air-brake maintenance will result in a wonderfully improved showing, as well as increased safety and a better movement of trains in heavy traffic.

"What are we to do to better our air-brake service which we are so candidly informed is not up to the highest standard? Procure the services of a first-class general air-brake inspector, give him full authority in everything pertaining to air-brakes, and hold him responsible, having him report directly to the Superintendent of Motive Power or the General Superintendent. The first and most important qualification of a general air-brake inspector is that he must be a leader, a man of character and ability, and competent to handle men. He should know the manufacturers' method of building brakes, etc. He should know the best designs for applying brakes to locomotives and cars, and know how to steer the drawing room away from the faulty ones. He should be thoroughly conversant with the construction and operation of brakes, train handling, and yard and shop repairing. He should be able to give proper and thorough instructions in the operation, inspection and repairs of all parts of the air-brakes. If he is supplied with an instruction car fitted up with air-brake material for instructing employees, he should put in alternate weeks in the car instructing, and on the road about the shops and yards, giving practical illustrations and object lessons. He should know all that is going on in the

air-brake line over the entire road, in all of the shops, offices and drawing rooms."

Mr. Nellis gives some very interesting accounts of the value of quick wit, and common sense in engineers in connection with air-brake difficulties, and shows how a loose joint or a defective washer may delay a train. Such care, however, should not be necessary with proper inspection. Inspection alone, however is not sufficient to insure entire reliability, and a convenient and efficient testing department should be equipped, and constantly used.

"A portion of the yards where freight and passenger cars lie before being made up into trains should be arranged with piping, suitable valves, etc., for testing the brakes on these cars while they are lying idle, and not wait until the train has been made up, engine coupled on and ready to depart. A large number of the principal railroads have installed such plants in both their passenger and freight yards.

"In addition to the yard testing plant there should be arranged suitable repairing facilities where brakes may be repaired when found to be in need. Tracks at loading sheds and freight houses, also other places where cars are stood for loading, should be piped so the brakes on those cars may be inspected and tested while the cars are being loaded."

The efficient performance of air brakes is largely dependent upon the care exercised in applying them, and this is of even more importance on long freight trains than on passenger trains. The best results are obtained by using two applications of the brakes in making a stop,—the first being a heavy application to check the speed of the train, and the final application, a lighter one, to bring the train to a standstill. Uniform adjustment of piston travel is another feature which should not be overlooked, and this, together with an automatic slack adjuster, will go far to give prompt and effective train control.

Wooden Pavements.

A RECENT paper before the American Society of Municipal Improvements, by Mr. F. A. Kummer, gives an interesting review of the past history of wooden pavements in the United States, with some suggestions as to future developments.

Three distinct phases marked the past use of wood pavements in American cities.

"The first step was an improvement on the corduroy road. It converted a mudhole into a passable way. The round or hexagonal blocks were not treated, consequently they rotted. They were one-third sap wood, consequently they rounded quickly on the edges. They were highly unsanitary because they absorbed street filth. They sank into ruts and holes because they had no foundation; but they were cheap; they eliminated the mud hole, and in that way served a good purpose.

"It occurred to some enterprising genius to improve this pavement by squaring the blocks and dipping them in tar. This form of pavement, generally known as the Nicholson block, was extensively laid in many cities to their great and lasting sorrow. Why anyone should have anticipated success with such a pavement is almost incomprehensible. In the first place, little or no care was taken in the selection of the timber; hard and soft, heart wood and sap, seasoned and unseasoned, all woods looked alike to the promoters of the pavement. A dipping in hot coal tar or pitch served to cover up the defects, and incidentally to seal up within the wood the moisture due to lack of seasoning, thus hastening dry or heart rot as much as possible. The introduction of laths between the blocks served to make large joints, and thereby to admit as much water as possible under the pavement. Sometimes the pavements rolled in billows like the sea. At this stage they were generally thrown away. The use of untreated planks on earth as a foundation was ingenious in its insufficiency. That part of the pavement that was not heaved up by the frost, went down by the rotting of the planks.

"As a third phase, creosoted wooden blocks on a proper concrete foundation have begun to be laid in a few places throughout the country. This is really a wooden pavement."

The manner in which properly constructed wood pavements will sustain a heavy traffic is shown by the behaviour of the pavements in Paris and London. In the rue de Rivoli in Paris the traffic is eight times heavier than on Fifth avenue or Madison avenue in New York, and the wear

is only one centimetre per year. Equally good results are had in London, and the traffic there is the heaviest in the world, including, as it does, the heavy omnibus lines.

The foundation for every kind of pavement should be first-class concrete, and hence there is no reason why this should be especially prescribed for wood pavements, it should be insisted on as a necessity.

"In constructing a perfect wooden pavement, two methods of treating the surface of the concrete may be adopted. It may either be covered with a very thin cushion of clean fine sand, not exceeding one inch in thickness, and thinner if the upper surface of the concrete will admit of it, or it may be floated with a grout of Portland cement and fine sand, mixed thick and brought to a true surface and grade by the use of a template, as in the case of a sand cushion. If the latter method is used, the blocks may either be set in the wet surface of the grout, and lightly tamped or rolled, or the grout may be allowed to harden and its surface be slushed with a coating of pitch or asphaltic cement, such as is often used in grouting joints with brick or granite block. Into this coating, while hot, the blocks should be set, and tamped or lightly rolled, as before. The blocks should be set as closely together as possible, both in the direction of the street and from curb to curb, and rammed tight every few courses. By laying the courses at an angle to the curb line, say thirty degrees, better results will be secured, as there is much less chance for the calks of horses' shoes to round off the edges of the blocks. After being laid the joints should be partially filled with very fine, clean sand, and the pavement rolled. A much heavier roller may be used with advantage where a sand cushion is used. The Boston pavements above referred to were mostly rolled with a 15-ton roller, and no damage whatever was done to the blocks. With bricks this would not have been the case. After rolling the joints should be fully filled with pitch or a good asphaltic cement.

Such a grout should be poured over the entire surface of the street and be swept into the joints with a wire broom. The surface of the street, after grouting, should be spread with a coating of fine, sharp sand, making a practically perfect roadway."

Mining in Mexico.

In view of the limited amount of scientific information available concerning the mining and metallurgical industries of Mexico, the very full paper by Dr. Joseph Struthers, in a recent issue of the *Engineering and Mining Journal* is a welcome addition to the stock of knowledge of that country. As Dr. Struthers remarks, apart from a few articles scattered through the papers of scientific societies and in the technical press, no attempt has been made to discuss in a systematic manner the mineral resources of this important country. Both under the native dominion and under the later Spanish rule Mexico has stood pre-eminent in the production of both gold and silver, and while untold wealth has been extracted from her many mines, there yet lies stored in the lower levels of operative mines, as well as in unexplored regions a vast quantity of precious and base metals.

Dr. Struthers begins with a description of the general geology of Mexico, and then takes up the various mining districts.

The mining regions follow the direction of the Sierra Madre range and extend from Oaxaca in the southeast to Sonora in the northeast, a distance of 2,574 kilometers of a general width of 402 kilometers. The richest mines so far discovered lie in the South Central Plateau, of from 1,370 to 2,900 meters elevation above the sea level. Probably the richest known argentiferous region in the whole world is on a line drawn from Oaxaca on the south, through Guanajuato to Guadaloupe, Chihuahua, on the north. Accor ing to official reports for the year 1900, there are 1092 mining districts in the republic, of which 553 are silver or silver-lead propositions, 237 gold mines and placers, 141 coal, petroleum, etc., 68 cinnabar, 41 copper, 36 lead and 16 tin, and during 1898 to 1899 taxes were paid on existing lodes to the number of 8,970, covering an area of 84,557 hectares.

"The mineral resources of Mexico are so vast in amount that the republic may be considered one of the richest mining countries in the world, and while the metal-bearing districts have been exploited during the past 400 years by innumerable mining enterprises and immense quantities of precious metals have been extracted, a great part of her mineral wealth still lies undis-

turbed, awaiting the application of modern methods of mining and treatment. Under the favoring conditions of railroad extension and influx of foreign capital and labor, Mexico will be placed in the foremost rank of the metal-producing countries of the world. Early in the nineteenth century Humboldt estimated the number of mines in Mexico to reach 3,000 and while many have been idle during recent years, the extension of railroads bringing remote regions into close communication has caused a revival of interest in the mining industry. In spite of imperfect methods of extraction, lack of proper transportation, inefficient labor and other drawbacks, Mexico has already produced more than one-third of the total output of silver in the world.

"Gold occurs in Mexico chiefly in Sonora on the slopes facing the Pacific Ocean near the gold-bearing regions of California, and its production from this source will probably be largely increased, especially since the Yaqui Reservation has been thrown open to the public. In Guerro and in Oaxaca as well, considerable gold is produced from shallow placers and from the crude arrastra treatment of ores, and in other districts deposits of this type have been reported. The precious metal also occurs in many silver ore deposits, principally in the State of Zacatecas. A number of old mines which have been closed down for years are being unwatered and placed in repair and with modern methods of working, the shafts will be extended to greater depths with advantage to the development of the mining industry. There are also immense heaps of tailings resulting from the primitive methods of ore treatment that are of sufficient value to yield a profit when worked by modern methods.

Dr. Struthers gives interesting data concerning the output of copper, lead, quicksilver and coal, and takes up each mining district in detail, giving accounts of the mines, smelters and transportation facilities. American enterprise has done much to develop these properties, and with the introduction of methods from the United States we may expect to see the mining and metallurgical industries of Mexico make rapid progress.

Electric Traction Stations in New York.

In a recent issue of the *Street Railway Journal* the great power stations of New York are discussed and criticised by Mr. William Kent, and some interesting points are brought out.

In the first place, although the conditions are very similar in all cases, the practice does not seem yet to be fully unified. Thus although all three of the great stations of New York are situated with an ample supply of water, the methods of condensation of steam differ, one using surface condensers, and another jet condensers, with separate condensers for each engine, while the third employs the central system to the extent of using a jet condenser for each four engines. The water available for condensation is not suitable for feed, being salt or brackish, and the use of jet condensers involves the additional cost for city water for boiler feed, but it has been maintained that this is preferable to the return of the condensed steam, with its entrained oil, to the boilers. Clearly there is a field for oil separators and filters here.

Mr. Kent believes that higher economy might be attained by the use of higher steam pressures, superheating, and higher rotative speed, but it must be remembered that in such stations there are other things besides steam economy which must be considered.

Above all things unfailing certainty of operation and freedom from breakdowns must be given first place, and this means that the highest degree of simplicity is desirable.

It has been clearly shown that in a great power station the cost of fuel is about one-half the total cost of the power, so that any mere saving in fuel does not mean a corresponding proportional reduction in the total cost of power. If the saving is made at the expense of an addition to the fixed or operative charges it may prove a dear bargain, and it has often been found that an economy in steam is not an economy in money.

The modern power house, like all great undertakings, is a compromise between many conflicting conditions, and as such it must be considered as a whole rather than in detail.

THE ENGINEERING INDEX

"THE KEYSTONE IN THE ARCH OF APPLIED SCIENCES IS THE ENGINEERING INDEX"

The following pages form an index to the contents of nearly two hundred of the leading engineering journals of the world, in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index item gives the following essential information about every article.

(1) The full title, (2) The name of its author,
(3) A descriptive abstract, (4) Its length in words,
(5) When published, (6) Where published.

We supply the article itself, if desired.

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer and works manager may quickly turn to what concerns himself and his special branches of work. Thus this Index makes it possible within a few minutes' time each month to inform one's self of every important article published anywhere in the world upon the subjects claiming one's special interest.

The original of any article referred to in the Index, together with all illustrations, can be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the journals indexed are given.

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CIVIL ENGINEERING

BRIDGES.

Arches.

Bridges in the Pan-American Exposition Grounds. Illustrated description of the method of constructing 30-ft. timber highway arches. 800 w. Eng Rec—Oct. 26, 1901. No. 43884.

The Elastic Arch (Sur la Voute Elastique). G. Poisson. A mathematical discussion of the general theory of the elastic arch subjected to a hydrostatic load. 1000 w. Comptes Rendus—Sept. 16, 1901. No. 43933 D.

The Luxemburg Stone Arch Viaduct. Illustrated description of a masonry high-

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way arch having a centre span of 275½ ft., the longest span of its kind now in existance. 1000 w. Eng Rec—Oct. 12, 1901. No. 43771.

The Rockville Bridge of the Pennsylvania. C. W. Hardt. Illustrated description of an imposing bridge nearly completed, costing nearly $1,000,000. 1200 w. R. R. Gaz—Oct. 25, 1901. No. 44016.

Brooklyn Bridge.

An Expert Report on the Improvement of the Brooklyn Bridge Terminals. Report of a board of engineers, with editorial comment. 5500 w. Eng News—Oct. 17, 1901. No. 43816.

The Brooklyn Bridge—Its Defects and Treatment. George S. Morison. Discusses the design of the bridge, and the proper remedy for the defects. 1000 w. R. R. Gaz—Oct. 18, 1901. No. 43819.

The Brooklyn Bridge—Its Defects and Treatment. Joseph Mayer and Edwin Duryea, Jr. A letter stating the reason why they did not advise replacing the whole superstructure of the bridge. 1100 w. R R Gaz—Oct. 25, 1901. No. 44015.

The Brooklyn Bridge. Report of the engineers appointed to examine the bridge and report its exact contdition. 9000 w. Ir Age—Oct. 10, 1901. No. 43683.

The Manhattan Terminal of the Brooklyn Bridge. Extracts from the report of a board of engineers, with editorial comments. Ill. 5400 w. R R Gaz—Oct. 18, 1901. No. 43820.

The Physical Condition and Safety Under Present Loads of the New York and Brooklyn Bridge. Report by Edwin Duryea, Jr. and Joseph Mayer, engineers appointed to investigate the safety of the bridge, with editorial comment. Ill. 30000 w. Eng News—Oct. 10, 1901. No. 43742.

Cincinnati.

Mill Creek Bridge, Cincinnati, O. Illustrates and describes details of a plate-girder through bridge about 80 ft. high. The two main girders are 213 ft. long over all, giving a clear span of 199 ft. between abutments. 1000 w. Eng Rec—Sept. 28, 1901. No. 43520.

Design.

Excessive Refinement in Bridge Design. Discusses features of design in recent German bridges which were tried and abandoned in the United States 20 years ago. 1100 w. Eng Rec—Oct. 26, 1901. No. 43883.

Some Thoughts Concerning Changes in Bridge Design. Editorial discussion of experience in regard to iron bridges and discussing also the cost of a masonry arch and points in its construction. 3000 w. Eng News—Sept. 26, 1901. No. 43527.

Draw-Bridges.

A Graphical Method for the Solution of Stresses in the Continuous Girder, as Applied to Draw-Bridges. George F. Barton. Describes this method which is simple and comprehensive, stating some of its advantages. 3500 w. Pro Am Soc of Civ Engrs—Oct., 1901. No. 44000 E.

German Bridges.

Two New German Bridges, with Transverse Articulation and Freely Suspended Floors. Illustrated description of the striking structural features of the recent bridges built across the Rhine at Worms, and across the Elbe at Harburg. 2200 w. Eng News—Oct. 17, 1901. No. 43818.

Military Bridges.

The Cluchagne System of Military Rafts and Bridges. From *La Nature*. Illustrated description. 600 w. Sci Am Sup—Oct. 12, 1901. No. 43740.

Pratt-Truss.

The Northport Bridge. Illustrated description of a combination single-track bridge having spans of 250 and 150 ft. The structure is an interesting example of a type of bridge used only where good wood is plentiful and metal expensive. 1900 w. Eng Rec—Oct. 19, 1901. No. 43837.

Redheugh Bridge.

The Redheugh Bridge, Newcastle-on-Tyne. Many illustrations of the details of an interesting structure between Newcastle and Gateshead, with brief description. 600 w. Engng—Oct. 4, 18, 1901. Two parts. No. 43764 each A.

Substructure.

Methods of Construction of the New Cambridge Bridge Substructure, Boston, Mass. Sanford E. Thompson. Illustrates and describes the pile driving; the cutting off of the piles; the construction of the cofferdams; and the concrete mixing and laying. 3300 w. Eng News—Oct. 17, 1901. No. 43814.

CANALS, RIVERS AND HARBORS.

Amsterdam.

An Account of the Progress of the Improvement of the Public Waterways in Amsterdam (Mededeelingen aangaande de in Uitvoering zijnde Werken voor de Geneetelijke Waterleidingen binnen Amsterdam). J. M. K. Pennink. An address before the Royal Institute of Engineers, describing the works now in progress. 3000 w. De Ingenieur—Sept. 28, 1901. No. 43991 D.

Canals.

Georgian Bay Canals. Discusses its construction from the commercial standpoint and the effects it would have on the trade of the Great Lakes. 4300 w. Marine Rev—Oct. 3, 1901. No. 43630.

The Canals of Canada. Reviews the existing and proposed canals and improvements, and gives reasons why an open wa-

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ter route from the Great Lakes to the sea should be maintained. 2000 w. Builder—Sept. 28, 1901. No. 43648 A.

Charles River.

Geological History of the Charles River. Frederick G. Clapp. An interesting study explaining why the river follows its present course, tracing the great courses, etc. Ill. 8,500 w. Tech Qr—Sept., 1901. Serial. 1st part. No. 43690 E.

Docks.

The Dock at Burnt Island. An illustrated description of a new dock on the Firth of Forth, at an important coal port. 2000 w. Transport—Oct. 18, 1901. No. 44020 A.

Dredge.

Suction Dredge for Harbor at Sabine Pass. Illustrated detailed description of a seagoing twin screw suction dredge to be used for harbor improvement. 1100 w. Marine Engng—Oct., 1901. No. 43624 C.

Dry-Dock.

Dry-Dock Foundation at Kiel, Germany, Laid from a Floating Caisson with Compressed Air. Brief illustrated description. 400 w. Eng News—Oct. 10, 1901. No. 43745.

Estuaries.

Marine and Estuarine Deposits. Prof. W. B. Scott. Lecture at the Wagner Inst., Philadelphia. An interesting description of these deposits in shallow and deep waters. 4000 w. Sci Am Sup—Oct. 12, 1901. No. 43741.

Harbor Improvement.

Description of Coos Bay, Oregon, and the Improvement of Its Entrance by the Government. L. M. Haupt. Continued discussion of paper by William W. Harts. 1800 w. Pro Am Soc of Civ Engrs—Sept., 1901. No. 43507 E.

Description of Coos Bay, Oregon, and the Improvement of Its Entrance by the Government. Continued discussion of paper by William W. Harts. 6700 w. Pro Am Soc of Civ Engrs—Oct., 1901. No. 44002 E.

Irrigation.

Extensive Project for Irrigating Egypt. Briefly outlines the works at present under construction and their cost, and also the projects under discussion. 1200 w. Sci Am—Oct. 12, 1901. No. 43734.

Types of Irrigation in the West. George Ethelbert Walsh. An interesting review of irrigation projects established in various parts of the western States, and their results. 3400 w. Gunton's Mag—Oct., 1901. No. 43634 C.

Light-Houses.

Improved Rapid Group Flashing Lights. Alan Brebner. Read before the Glasgow Congress. Mainly a description of Brebner's eclipsing mechanism for lighthouses. Ill. 2000 w. Engng—Oct. 18, 1901. No. 44025 A.

River Improvement.

Improving Rivers in China. Concerning the improvement of the Peiho and Whangpoo rivers, with the regulations. 2500 w. U. S. Cons Repts, No. 1149—Sept. 30, 1901. No. 43510 D.

Modern Methods of River Regulation (Ueber Neuere Flussregulierungs-Methoden). Ignaz Pollak. A review of the latest Continental practice involving the study and maintenance of the natural bed of the stream. Two articles. 8000 w. Zeitschr d Oesterr Ing u Arch Ver—Oct. 4, 11, 1901. No. 43944 each B.

The Regulation of River Beds at Railway Crossings (Verruiming en Vernauwing van hel Rivier bed bij Spoorwegovergangen). A. B. Marinkelle. Describing especially the manner in which the channel of the Maas has been regulated at the bridge at Buggenum, Holland. 3500 w. De Ingenieur—Sept. 14, 1901. No. 43990 D.

The Regulation of the Oppa at Jägerndorf (Die Oppa-Regulierung in Jägerndorf). M. Kohut. With map and section, showing the construction of dikes for controlling the channel of the river Oppa, as it passes through the town of Jägerndorf, Bohemia. 1800 w. Zeitschr d Oesterr Ing u Arch Ver—Sept. 27, 1901. No. 43943 B.

Sluice Gates.

Great Sluice Gates of the Nile Irrigation Works. Brief illustrated description of the device employed. 700 w. Sci Am—Oct. 12, 1901. No. 43735.

Zuider Zee.

The Drainage of the Zuider Zee (Desséchment du Zuider Zée). A review of the latest plans for the recovery of successive portions of the Zuider Zee as provided in the scheme now before the government of Holland. 1500 w. Revue Technique—Sept. 25, 1901. No. 43929 D.

The Zuider Zee. An outline of the scheme for enclosing this large area of the sea and reclaiming the land. 1200 w. Engr, Lond—Sept. 27, 1901. No. 43640 A.

CONSTRUCTION.

Building Details.

Girders in the Colonial Building, Boston. Illustrates and describes unusual steel work details in a large theater. 1300 w. Eng Rec—Oct. 12, 1901. No. 43775.

Exposition Buildings.

External Color of the Pan-American. Charles H. Coffin. A critical discussion of the color scheme introduced in the build-

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ings. Ill. 1899 w. Br Build—Oct., 1901. No. 44041 D.

The Buildings of the Glasgow International Exhibition, 1901. James Miller. Brief illustrated descriptions of the principal buildings. 1100 w. Jour Roy Inst of Brit Archts—Sept. 28, 1901. No. 43855 B.

The Buildings of the Louisiana Purchase Exposition. A general outline of the architectural scheme at the St. Louis fair. 700 w. Eng Rec—Oct. 26, 1901. No. 43,893.

Foundations.

Earth Movements, Underground Water and Foundations. Extract from letter of Mr. Somers Clark, concerning the condition of St. Paul's Cathedral, London. Also discussion of the subject by Dr. G. Johnsone Stoney. 2800 w. Stone—Aug., 1901. No. 43567 C.

Pneumatic Caisson Foundations of the New York Stock Exchange Building. An illustrated detailed description of very interesting and rapid work, showing new methods of excavation. 4000 w. Eng Rec—Sept. 28, 1901. No. 43519.

Framework.

The Stresses in Compression Members of Simple Framed Beams (Die Berechnung der Spannungen in den Pfosten einfacher Fachwerkbalken). A. Ostenfeld. An analytical examination for various conditions of loading. 1000 w. Zeitchr d Ver Deutscher Ing—Oct. 5, 1901. No. 43,906 D.

Grain Elevator.

The New 3,100,000-Bushel Steel Grain Elevator for the Great Northern Ry., at West Superior, Wis. Description and illustrations of the construction and equipment. 2700 w. Eng News—Sept. 26, 1901. No. 43526.

India.

The Periyar Dam and Irrigation Works, Southern India. A full presentation of this important engineering work, its plan and purpose, construction, material, power plant, etc. Ill. 7500 w. Eng News—Oct. 24, 1901. No. 44010.

Roofs.

Steel Armory Roofs. H. G. Tyrrell. Facts relating to steel roofs that will be of assistance in securing an approximate estimate of the amount of steel in a proposed roof. 900 w. Archts and Builds Mag—Oct., 1901. No. 43670 C.

The East Orange Town Hall Roof. Illustrated description of an unusual type of wooden roof truss. 500 w. Eng Rec—Oct. 26, 1901. No. 43891.

The Tremont Church Roof, New York. Illustrated description of unusual pointed hingeless arch trusses for a 73x95 ft. auditorium. 1100 w. Eng Rec—Oct. 19, 1901. No. 43839.

Subway.

Moving a Long Brick Wall. Illustrated description of the method of enlarging a section of the New York Rapid Transit Railway subway by moving back the retaining walls. 800 w. Eng Rec—Oct. 26, 1901. No. 43887.

The New Subway in New York City. Charles Prelini. Reviews the various proposals for rapid transit, and begins an illustrated detailed description of the work now in progress. 3200 w. Engng—Oct. 4, 1901. Serial. 1st part. No. 43762 A.

Tarnsey Act.

Building Construction Under the Tarnsey Act and Suggestions for Modifying It. William A. Boring. Suggestions based on the author's experience in connection with the immigrant station on Ellis Island, N. Y., for remedying the defective features of the law governing the work of architects employed on national buildings. 3500 w. Eng Rec—Oct. 26, 1901. No. 43890.

Tunnels.

The Simplon Tunnel. Illustrates and describes the works in progress on the northern or Swiss side of the mountains. 2400 w. Engr, Lond—Sept. 27, 1901. No. 43642 A.

The Walworth Street Sewer Tunnel, Cleveland. Illustrates and describes difficult construction work in building a tunnel under the tracks of the Big Four R. R., through very soft, wet ground. 1000 w. Eng Rec—Sept. 28, 1901. No. 43521.

Warehouses.

Grain Warehouses in Russia (Les Magasins à Blé en Russie). G. Espitallier. Describing especially the large warehouses at Nikolaieff, on the Black Sea, and at Windau on the Baltic. 2000 w. 1 plate. Génie Civil—Sept. 21, 1901. No. 43914 D.

MATERIALS.

Buckling.

The Theory of Buckling (Zur Theorie der Knickfestigkeit). Alois Schneider. A discussion of the various formulas from the time of Euler to the present, with a mathematical treatment of the elastic theory. Two articles. 7500 w. Zeitschr d Oesterr Ing u Arch Ver—Sept. 27, Oct. 4, 1901. No. 43941 each B.

Cement.

Possibilities for Portland Cement manufacture on the Pacific Coast. A. H. Cederberg. Discusses the situation, cost of plant, etc. 1100 w. Min & Sci Pr—Oct. 12, 1901. No. 43812.

The Rotary Kiln Process of Cement Manufacture. William Harry Stanger

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and Bertram Blount. Abstract of a paper presented to the Inst. of Civ. Engrs., with editorial. An exposition of the theory and practice of this process and of the adaptability and economy of the rotary kiln. Ill. 14400 w. Eng News—Oct. 24, 1901. No. 44012.

Cement-Making.

The New Plant of the Alpha Portland Cement Company at Alpha, N. J. Illustrated description of a plant having ten rotary kilns. The various processes of manufacture are described successively and the special features of the plant, particularly the conveying apparatus. 2800 w. Eng Rec—Oct. 5, 1901. No. 43657.

Ceramics.

Ceramics versus Stone in Architecture. Reprint of an article from *La Ceramique*, concerning the employment of ceramics, and the reasons why they are not popular with architects. 1400 w. Stone—Aug., 1901. No. 43568 C.

Concrete.

Some Primary Causes of Expansion and Contraction in Portland Cement Concrete and Mortars. H. Howard Humphreys. Examines in detail the causes that produce disruptive stresses and disintegration. 3800 w. Builder—Oct. 5, 1901. No. 43,750 A.

The Advance of Concrete Construction. An illustrated description of the new car shops at Elizabethport, N. J.; all the buildings, with one exception, are being constructed with concrete walls, and some have the roof of concrete also. 1400 w. Ir Age—Oct. 3, 1901. No. 43569.

Mortar.

Note on the Consolidation of Mortar. George W. Rafter. A record of tests ma le by the writer. 500 w. Pro Am Soc of Civ Engrs—Oct., 1901. No. 44001 E.

Reinforced Concrete.

Cement-Iron Construction (Cement-Ijzerconstructies). L. A. Sanders. A discussion of the Hennebique, Monier, and other systems, with especial reference to bridge construction. 3000 w. De Ingenieur—Aug. 24, 1901. No. 43995 D.

Some Examples of Concrete and Expanded Metal in Municipal Structures. Illustrated description of concrete-steel work in the foundations of pavements for water conduits and for outlet sewers. 1200 w. Eng Rec—Oct. 26, 1901. No. 43886.

Tests of Concrete and Concrete-Iron Construction (Zeber Versuchsergebnisse bei Erprobung von Beton und Beton-Eisen Constructionen). J. A. Spitzer. With data and results of a number of tests of beams, plates, etc., including diagrams of loads and deflections. 5000 w. 1 plate. Zeitschr d Oesterr Ing u Arch Ver—Oct. 11, 1901. No. 43045 B.

Use of Steel in Concrete Construction. Illustrated description of forms in which this material is used. 900 w. Sci Am Sup—Oct. 12, 1901. No. 43738.

MUNICIPAL.

Drainage.

The New "Drainage By-Laws" of the London County Council. A review of the by-laws recently adopted. 3200 w. Builder—Sept. 28, 1901. No. 43649 A.

Garbage Crematory.

The Decarie Garbage Crematory at Minneapolis. Illustrated description of the incinerators which are essentially a modification of water-tube boilers. 900 w. Eng Rec—Oct. 5, 1901. No. 43659.

Pavements.

Pavement Guarantees. George W. Tillson. Paper read before the Am. Soc. of Munic. Engr. on the different classes of guarantees and the best form of each. 3900 w. Eng Rec—Oct. 12, 1901. No. 43778.

Recent Experience with Wood Pavements. Extracts from a paper by B. T. Wheeler describing pavements in Boston of pine blocks treated by the creo-resinate process. 2300 w. Eng Rec—Oct. 5, 1901. No. 43661.

The Improvement of Streets and the Wood Pavements of Paris (Die Strassenbefestigung insbesondere das Holzpflaster in Paris). Alexander Swetz. A comparison of the cost and advantages of stone, wood, asphalt and macadam for street pavements, with especial reference to the wood block pavements of Paris. Serial. Part I. 2500 w. Zeitschr d Oesterr Ing u Arch Ver—Oct. 11, 1901. No. 43946 B.

Wooden Pavements at Home and Abroad. Extracts from a paper by F. A. Kummer, sketching the history of such pavements and describing the latest types in the United States, France and England. 4000 w. Eng Rec—Oct. 26, 1901. No. 43892.

Public Works.

Changes in the Management of Public Works, New York City. N. P. Lewis. An outline of the administration of public works under the charter taking effect Jan. 1, 1902. 1000 w. Eng Rec—Oct. 26, 1901. No. 43889.

Refuse.

Refuse Disposal in the District of Columbia. Dr. William C. Woodward. Extracts from a paper read before the Am. Pub. Health Assn. Reviews the history of the past ten years in the city of Washington. 3500 w. Eng Rec—Sept. 28, 1901. No. 43525.

Sewage Disposal.

Boston's Sewage Disposal Plant. From the *Boston Transcript*. Descriptive. 2000

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w. Dom Engng—Oct. 15, 1901. No. 43832 C.

Papers on Sewage Purification Read Before the Glasgow International Engineering Congress. Abstract of papers and discussions with editorial comment. 5500 w. Eng News—Oct. 10, 1901. No. 43744.

Recent Sewerage Work in Worcester, Mass. Illustrates and describes recent difficult sewerage construction, sewage interceptors, and full notes on the operation of a disposal plant, employing chemical precipitation, intermittent filtration and a septic tank. 3600 w. Eng Rec—Oct. 26, 1901. No. 43885.

Septic Tank and Double Contract Filter Beds for Treating the Sewage of Glencoe, Ill. H. D. Wyllie. Illustrates and describes the works, grit chamber, septic tank, filters, method of working, etc. 800 w. Eng News—Oct. 24, 1901. No. 44,014.

Sewage Disposal at a Leper Asylum. Outlines an interesting and instructive series of experiments carried out at the Matunga Leper Asylum, at Bombay, as given in a recent report by C. C. James. 3500 w. Engr, Lond—Oct. 11, 1901. No. 43,867 A.

The New Sewage Disposal Plant at Madison, Wis. F. E. Turneaure. Read before the Am. Soc. of Munic. Eng. An account of the various methods tried, the plant built and condemned, and a description of the plant in progress of construction, consisting of a septic tank and rapid filter. 3700 w. Eng News—Oct. 17, 1901. No. 43815.

The Septic Tank System at Glencoe, Ill. Illustrated description of septic tanks and filters built to treat 25,000 gallons of sewage daily. 900 w. Eng Rec—Oct. 19, 1901. No. 43838.

The Vancouver, B. C., Septic Tanks. Illustrated description of tanks for treating the sewage before discharging it into salt water. 400 w. Eng Rec—Oct. 12, 1901. No. 43772.

Sewers.

Sewer Ventilation Experiments at Leicester, England. Review of paper by E. G. Mawbey, giving the results of nearly 3000 experiments with different systems of sewer ventilation. 1800 w. Eng Rec—Oct. 12, 1901. No. 43773.

The 14th Ave. Sewer and 60th St. Sewer Tunnel Work, Brooklyn, N. Y. Illustrates and describes interesting sewer work through fine sand carrying considerable water. Also deep manhole construction. 800 w. Eng News—Oct. 10, 1901. No. 43743.

WATER SUPPLY.

Analysis.

Standard Methods of Water Analysis. Second report presented by the Committee to the Am. Pub. Health Assn. Recommends methods to be pursued in physical, microscopical and quantitative bacterial examinations. 3600 w. Eng Rec—Sept. 28, 1901. No. 43523.

Belfast.

Belfast Water Supply. An illustrated account of the recent extensions. 2000 w. Engr, Lond—Oct. 18, 1901. No. 44029 A.

Buffalo, N. Y.

The Water-Works System of the Pan-American City. An illustrated description of this fine municipal plant. 1700 w. Sci Am Sup—Oct. 5, 1901. No. 43605.

Consumption.

The Consumption of Water in Municipal Supplies and the Restriction of Waste. Clemens Herschel. Continued informal discussion of this subject. 1700 w. Pro Am Soc of Civ Engrs—Sept., 1901. No. 43503 E.

The Consumption of Water in Municipal Supplies and the Restriction of Waste. A continuation of the informal discussion on this topic. 4000 w. Pro Am Soc of Civ Engrs—Oct., 1901. No. 44005 E.

Cuba.

The Water-Works of Guantanamo, Cuba. S. D. Rockenbach. Illustrated detailed account of the work, with particulars concerning the region and conditions to be met. 2500 w. Pro Am Soc of Civ Engrs—Sept., 1901. No. 43501 E.

Eels.

Eels in Water Works and Their Control. Dr. George W. Field. Gives an account of the habits and breeding of eels, and suggests ways of preventing trouble from them in water works. General discussion. 6000 w. Jour N Eng Water Wks Assn—Sept., 1901. No. 43697 F.

Electrolysis.

Electrolysis of Water and Gas Pipes, Resulting from Electrical Currents Escaping from Street Railways. Edwin P. Mathews. Read at the Central States Water-Works Assn. Refers especially to conditions in Dayton, Ohio, but the remarks are of general application. 3400 w. Fire & Water—Oct. 12, 1901. No. 43765.

Filtration.

The Lawrence, Mass., City Filter: A History of Its Installation and Maintenance. Continued discussion of paper on this subject by Morris Knowles and Charles Gilman Hyde. 11300 w. Pro Am Soc of Civ Engrs—Sept., 1901. No. 43,504 E.

Fire Protection.

The Apportionment of Charges for Private Fire Protection, and the Means of Controlling the Supply for Such Service. Topical discussions, and report of committee appointed to consider this subject.

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1600 w. Jour N Eng Water Wks Assn—Sept., 1901. No. 43698 F.

Inspection.

The Work of Sanitary Inspection on the Metropolitan Water-Works. William W. Locke. Read before the N. E. Water-Works Assn. Calls attention to the dangers through pollution of the sources of water supply by house and barn drainage, suggesting means of prevention. 2700 w. Eng Rec—Sept. 28, 1901. No. 43522.

Ozone.

The Sterilization of Water by Ozonized Air (Die Wassersterilisierung durch Ozonisierte Luft). F. Krall. A description of the Abraham & Marmier process for sterilizing water for household use. 1500 w. Elektrochem Zeitschr—Aug. 1901. No. 43986 H.

Statistics.

Water Works Statistics for the Year 1900, in Form Adopted by the New England Water-Works Association. Compiled by Charles W. Sherman, 3000 w. Jour N Eng Water Wks Assn—Sept., 1901. No. 43696 F.

Water-Meters.

The Water Meter as a Sanitary Agent. M. N. Baker. Read before the Am. Soc. of Munic. Imp. Discusses the benefits from the use of meters, claiming that they cause purer water supplies, freer use of public water, extension of sewerage systems, and render more money available for sanitary improvements. 1300 w. Eng News—Oct. 10, 1901. No. 43746.

MISCELLANY.

Stresses.

Calculating the Stresses in Hinged Arched Ribs. Charles Lean. Describes a method requiring only the ordinary rules of arithmetic, and providing co-efficients applicable to other ribs of any span, depth or proportion, and amount of live to dead loads. Ill. 2000 w. Engr, Lond—Sept. 27, 1901. No. 43641 A.

Surveying.

A Practical Improvement in Tachymetry (Eine Praktische Neuerung beim Tachymetrieren). S. Wellisch. With especial reference to the reduction of vertical angles to a horizontal plane. 1500 w. Zeitschr d Oesterr Ing u Arch Ver—Sept. 27, 1901. No. 43942 B.

ELECTRICAL ENGINEERING

COMMUNICATION.

Brussels.

The New Telephone Station in Brussels (Die Neue Fernsprech-Vermittelungsanstalt in Brüssel). A description of the new central telephone station. The glow-lamp signal is used, and the central battery system of the Western Electric Co. of America. 2500 w. Elektrotech Zeitschr—Sept. 12, 1901. No. 43969 B.

Cables.

Modified Blavier Test. Walter J. Murphy. Describes a method affording a means of localizing a fault with minimum assistance at the further end. 1400 w. Elect'n, Lond—Oct. 11, 1901. No. 43,856 A.

Conductors.

A Note on Loaded Conductors. M. I. Pupin. Gives numerical and graphical illustrations relating to the system of the author for reducing the attenuation and distortion of telephonic currents in cables and long land lines. 800 w. Elec Wld & Engr—Oct. 12, 1901. No. 43768.

Induction.

The Prevention of Induction in Telephone Cables (Ueber Induktions-störung in Fernsprechkabeln mit Doppelpaarrig Verteilten Drähten). J. H. West. Showing how the conductors in telephone cables in which there are two pairs of wires may be so arranged as mutually to destroy induction effects. 1500 w. Elektrotech Zeitschr—Oct. 3, 1901. No. 43979B.

Multiplex.

Simultaneous Multiplex and Ordinary Telegraphy on the Same Circuit (Sur l'Emplor Simultané de la Telegraphie Multiplex et de la Telegraphie Ordinaire dans le Même Circuit). E. Mercadier. A discussion of the experiments of Cailho between Paris and Bordeaux. 600 w. Comptes Rendus—Sept. 16, 1901. No. 43934 D.

Repeater.

A New Automatic Telegraph Repeater. Illustrates and describes an invention of Julio E. Cordovez for repeating telegraphic messages both with and without the use of sounders or other receivers at intermediate stations. 1000 w. Sci Am—Oct. 19, 1901. No. 43823.

Space Telegraphy.

Recent Progress in Wireless Telegraphy (Les Derniers Progrès de la Télégraphie

sans Fil). An abstract translation of the lecture of Professor Slaby, recently delivered at Charlottenberg, Berlin. 3000 w. Revue Technique—Sept. 25, 1901. No. 43924 D.

Wireless Telegraphy. A summary of progress made by the various nations during the past year. 2500 w. Marine Rev—Oct. 17, 1901. No. 43835.

Telephones.

Making Molds for Telephone Receiver Work. Joseph V. Woodworth. Illustrates and describes molds used in manufacturing imitation rubber or composition goods for various purposes. 900 w. Am Mach—Oct. 24, 1901. No. 43874.

Telephony.

Changing a Magneto Drop to a Central Battery System. Charles L. Goodrum. Illustrated description of the work. 700 w. Elec Wld & Engr—Oct. 5, 1901. No. 43686.

Cross-Talk in Telephone Cables, with Wires Laid Up in Fours. Jul. H. West. From the *Electrotechnische Zeitschrift*. Discusses the reason why cross-talk appears and some means of eliminating it. 1400 w. Elect'n, Lond—Oct. 11, 1901. No. 43857 A.

DISTRIBUTION.

Converters.

A New Method of Obtaining Continuous Currents from Alternating Systems (Ueber ein Neues System der Entnahme von Gleichstrom aus Wechselstromnetzen). F. J. Koch. By the use of a synchronously revolving commutator in connection with storage batteries, alternating currents are conveniently and economically converted. 1500 w. Elektrotech Zeitschr—Oct. 10, 1901. No. 43981 B.

Tests of Synchronous and Asynchronous Converters (Essais de Convertisseurs Synchrones el Asynchrones). Giving data and diagams of trials of both types as built by the Oerlikon works in Switzerland. 1000 w. Génie Civil—Sept. 21, 1901. No. 43915 D.

Improved Leblanc Converter (Neuer Umformer von Leblanc). C. Feldmann. A description of the new converter made by the Helios Company, of Cologne; with a mathematical analysis of its action. 4000 w. Elektrotech Zeitschr—Sept. 26, 1901. No. 43974 B.

Notes on Rotary Converters and Phase-Swinging. W. M. Thornton. On the use of damping coils, explaining their action. 2400 w. Elect'n, Lond—Sept. 27, 1901. Serial. 1st part. No. 43651 A.

Protection.

The Protection of Fire and Police Telegraph Systems from High-Tension Currents and Lightning. Walter M. Petty. Read at the convention of the International Assn. of Munic. Elect'ns. Describes apparatus in use and discusses what is necessary. 5000 w. Fire & Water—Oct. 19, 1901. No. 43843.

Transformers.

See Electrical Engineering, Measurement.

ELECTRO-CHEMISTRY.

Accumulator.

A method for Increasing the Capacity of Accumulators (Ein Verfahren zur Steigerung der Kapacität der Akkumulatoren). C. Heim. An examination of the influence of the increase in temperature upon the capacity of accumulators. 5000 w. Elektrotech Zeitschr—Sept. 26, 1901. No. 43975 B.

Alkalies.

The Electrolytic Production of Caustic Alkalies (Verfahren zur Elektrolytischen Herstellung von Aetzalkali). H. A. Cohn and E. Geisenberger. Description of apparatus for decomposing alkaline chlorides and the production of caustic alkalies and chlorine. 1200 w. Electrochemische Zeitschr—Sept., 1901. No. 43988 H.

Cadmium Cell.

A Cadmium Standard Cell. Henry Tinsley. Illustrates and describes a cell which has been tested and is regarded as fairly satisfactory. 1300 w. Elect'n, Lond—Oct. 18, 1901. No. 44036 A.

Current Distribution.

The Distribution of Current Lines in Elektrolytes (Streuung der Stromlinien in Elektrolyten). W. Pfanhauser. An examination of the manner in which the current flows from anode to cathode in electrolytic baths. 1500 w. Zeitschr f Elektrochemie—Sept. 26, 1901. No. 43985 H.

Electrolysis.

The Electrolysis of Fused Salts. C. C. Garrard. Reviews an article by Prof. Lorenz, giving a sketch of the present position of the investigations at Zürich. 1700 w. Elec Chem & Met—Sept., 1901. No. 43751 A.

Progress.

Electrochemical and Electrometallurgical Industry. John B. C. Kershaw. This introductory article deals with progress in the United States. 2800 w. Elec Rev, N. Y.—Oct. 12, 1901. Serial. 1st part. No. 43783.

ELECTRO-PHYSICS.

Conductivity.

On the Change of Conductivity of Metallic Particles Under Cyclic Electromotive Variation. Prof. Jagadis Chunder Bose. Read before the British Assn. Deals with those substances which show a diminution of resistance, with typical instances

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of non-recovering and self-recovering substances, describing the peculiarities of their cyclic characteristic curves. 2500 w. Elect'n, Lond—Sept. 20, 1901. Serial, 1st part. No. 43552 A.

Dielectrics.

Recent Investigations upon Dielectric Bodies (Neuere Beiträge zur Naturgeschichte Dielektrischer Körper). Dr. M. von Hoor. An exhaustive study of the various materials suitable for condenser dielectrics, giving details of experiments, and forming a continuation of the author's former researches. Serial. Part I. 4000 w. Elektrotech Zeitschr—Sept. 5, 1901. No. 43976 B.

Heat Effects.

The Effect of Heat on New Varieties of Iron (Glühversuche mit Neueren Eisensorten). Max Mauermann. Data and results of extended experiments upon the effect of heat upon the magnetic properties of irons. 1500 w. Elektrotech Zeitschr—Oct. 10, 1901. No. 43982 B.

Interrupter.

A Simple and Efficient Mercury Jet Interruption for Röntgen Ray Induction Coils. R. H. Cunningham. An illustrated description of a convenient revolving mercury interrupter for use in the primary circuit of a Ruhmkorff coil. 1500 w. Elec Wld & Engr—Oct. 12, 1901. No. 43769.

Magnetic Curves.

Notes on Magnetic Curves. Jesse Pawling, Jr. Gives full solutions of examples 37, 38 and 39, page 51, of *Minchin's Statics*, Vol. 1, fifth edition. 600 w. Jour Fr Inst—Oct., 1901. No. 43692 D.

Magneto-Electricity.

Adaptation to Discovery. James Wilson. Reviews the early work that showed that mechanical motion could be obtained through the forces of magnetism and electricity. 1100 w. Am Mach—Oct. 3, 1901. No. 43585.

Rectifier.

The Theory of the Electrolytic Rectifier. Dr. K. Norden. Advances a complete theory of the modern electrolytic rectifier, developed according to experimental researches. 2700 w. Elec Wld & Engr—Oct. 26, 1901. No. 43899.

Variable Currents.

The Variability of Currents (Sur l'Etat Variable des Courants). A. Petot. An examination of the laws which govern the variability of electric currents opposed by varying resistances. 1200 w. Comptes Rendus—Sept. 30, 1901. No. 43936 D.

GENERATING STATIONS.

Alternators.

The Inductor Alternator. Edward Heitmann. Claims that this type of alternator, when properly designed and constructed, will meet the most severe conditions encountered in the operation of generators of all sizes and types. Ill. 1100 w. Elec Wld & Engr—Oct. 5, 1901. Serial. 1st part. No. 43687.

Dynamos.

Continuous-Current Dynamos. Henry A. Mavor. Abstract of a paper read before the Glasgow Congress, aiming at a standard system of dynamo design and manufacture, with a review of the paper by Claude W. Hill. 4800 w. Elec Rev, Lond—Sept. 20, 1901. No. 43549 A.

Modern Commutating Dynamo Machinery, with Special Reference to the Commutative Limits. H. M. Hobart, Read before the Glasgow Congress. Gives views regarding the continuous current dynamo-electric machine, describing types. Ill. 3500 w. Elec Engr, Lond—Sept. 27, 1901. Serial. 1st part. No. 43654 A.

England.

Walthamstow Electricity Works. Illustrates and describes the buildings, gas plant, gas engines, dynamos, &c. 500 w. Elec Rev, Lond—Oct. 18, 1901. No. 44032 A.

Germany.

Statistics of Electric Plants in Germany (Statistik der Elektrizitätswerke in Deutschland). The usual annual review of the growth of electric stations in Germany, with full tabulated data of all plants. 15000 w. Elektrotech Zeitschr—Sept. 5, 1901. 43968 B.

Hydro-Electric Plant.

The Carbide Works at Flums (Das Carbidwerk Flums). A description of the hydro-electric plant at Flums, Switzerland, for the manufacture of calcium carbide. Four articles. 4000 w. Schweizerische Bauzeitung—Sept. 14, 28, Oct. 5, 12, 1901. No. 43989 each B.

The Plant of the Lehigh Power Company at Raubsville, Pa. Illustrated description of a hydraulic power plant having two turbine chambers, the turbines in the first working under a 33-ft. head, and in the second under an 18-ft. head. 1100 w. Eng Rec—Oct. 5, 1901. No. 43658.

Water-Power Development at Chaudiere Falls, Que. An account of the undertaking with illustrated description of the terials used, etc. 2500 w. Can Engr—Oct., 1901. Serial. 1st part. No. 43575.

Italy.

Great Electric-Power Installations of Italy. Enrico Bignami. Signor Bignami's present paper describes and illustrates the great power plant at Vizzola-Ticino. 3000 w. Engineering Magazine—Nov., 1901. No. 44051 B.

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Karlsruhe.

The Electric Plant at Karlsruhe (Das Elektricitätswerk der Stadt Karlsruhe). F. Winawer. A fully illustrated account of the steam and electric plant. A polyphase system, with transformers is used. 2000 w. Elektrotech Zeitschr—Oct. 10, 1901. No. 43980 B.

Paris.

The Malakoff—Les Halles Electric Tramway (Tramway Electrique de Malakoff—Les Halles). An account of a Paris suburban tramway, using overhead trolley without the city, and storage battery within the fortifications, the battery being charged from the line. 1000 w. 1 plate. Génie Civil—Oct. 12, 1901. No. 43921 D.

The Malakoff Power Station (Usine Electrique de Malakoff). Ch. Dantin. Describing an important generating station in the southwestern part of Paris, supplying current to four tramway systems with a total length of 40 kilometres. 2000 w. 1 plate. Génie Civil—Oct. 5, 1901. No. 43918 D.

Power Plant.

The Power Station at Hazneck, Switzerland. Illustration, vertical section and plan of the power house, with detailed description. 2200 w. Eng Rec—Sept. 28, 1901. No. 43524.

Power Stations.

The Influence of Polyphase Apparatus on the Design of Railway Power Stations. J. E. Woodbridge. On the need of modifying the design to suit the electrical apparatus, illustrating the influences by preventing actual designs based as nearly as possible on usual practice. Ill. 3400 w. Elec Wld & Engr—Oct. 5, 1901. Serial. 1st part. No. 43684.

Storage Batteries.

Storage Batteries Located in Power Stations. W. E. Harrington. Read before the Am. St. Ry. Assn. Considers the conditions that will lead to economical results, and the questions to be considered. 2300 w. St Ry Rev—Oct. 12, 1901. No. 43805 C.

Versailles.

Electric Traction on the Invalides-Versailles Line (La Traction Electrique sur la Line des Invalides à Versailles). F. Drouin. Describing especially the power station at Moulineaux, containing nine direct-connected generating sets of 800 kilowatts each. 2500 w. 1 plate. Génie Civil—Sept. 14, 1901. No. 43910 D.

LIGHTING.

Accounts.

Customers' Accounts for Electric Light Companies. S. E. Moore. Read before the Accountants' Assn. Suggestions relating to the accounting department. 2300 w. St Ry Rev—Oct. 12, 1901. No. 43806 C.

Arcs.

On the Resistance and E. M. F.s of the Electric Arc. W. Duddell. Abstract of a paper before the Royal Soc. Gives a résumé of previous work showing the errors, and considers that the testing current must be very small and completed in an exceedingly short time. Describes methods, &c. 2700 w. Elect'n, Lond—Oct. 4, 1901. No. 43753 A.

Photographing the Electric Arc. Prof. A. C. Stone. Notices briefly some points concerning arc light carbons in operation as indicated by direct photographs of the arc itself. 1200 w. Sci Am—Oct. 19, 1901. No. 43825.

Battersea.

Battersea Electricity Works. An illustrated description of an English electric-lighting installation. 3300 w. Elec Rev, Lond—Oct. 4, 1901. No. 43755 A.

Legal Relations.

The Relation of Electric Light Companies to Municipalities from a Legal Standpoint. D. L. Gaskill. Selections from a paper read before the Ohio Elec. Lgt. Assn. Considers the relations under the headings of franchises, contracts for lighting, private lighting and right of way on public streets as affecting private property. 2800 w. Elec Rev, N. Y—Oct. 5, 1901. No. 43613.

Photometry.

See Electrical Engineering, Measurement.

Stoke Newington.

Stoke Newington Lighting. A report by R. E. Crompton on the lighting of Stoke Newington by electricity, with editorial. 3000 w. Elec Engr, Lond—Oct. 18, 1901. No. 44034 A.

MEASUREMENT.

Electrical Energy.

The Determination of Electrical Energy (Zur Wertbestimmung Elektrischer Kraft). O. Schmidt. An estimate of the energy stored in calcium carbide. Also a discussion of the generation of gas by electricity in localities poor in coal. 1200 w. Zeitschr f Elektrochemie—Aug. 1, 1901. No. 43983 H.

Galvanometers.

On Galvanometers of High Sensibility. C. E. Mendenhall and C. W. Waidner. An illustrated account of an instrument possessing advantages as regards convenience and ease of manipulation, giving results of some experiments with minute magnets. 3400 w. Am Jour of Sci—Oct., 1901. No. 43588 D.

We supply copies of these articles. See page 483.

Instruments.

The "Pierre de Plan" Station of the Electric Plant at Lausanne (Apparatenanlage in der Centrale und Umformerstation "Pierre de Plan" des Elektricitätswerke der Stadt Lausanne). K. P. Täuber. Describing especially the measuring instruments and their mounting and connections. 3500 w. Elektrotech Zeitschr—Oct. 3, 1901. No. 43978 B.

Photometry.

An Improved Apparatus for Arc-Light Photometry. Charles P. Steinmetz. Describes an equipment, designed by the writer, for the Photometric Laboratory of Purdue University, which is in satisfactory operation. Ill. 2300 w. Trans Am Inst of Elec Engrs—Aug.-Sept., 1901. No. 43801 D.

An Improved Apparatus for Arc-Light Photometry. Abstract of a paper by Prof. Matthews, read before the Am. Inst. of Elec. Engrs., with editorial comment. Describes and illustrates the equipment, explaining its operation. 2200 w. Elec Wld & Engr—Oct. 5, 1901. No. 43688.

Standards.

Standards for Testing Electrical Machinery (Normalien zur Prüfung von Elektrischen Maschinen und Transformatoren). The preliminary report, presented at the Dresden meeting of the German Electrotechnical Association, for tentative use for one year. 3500 w. Elektrotech Zeitschr—Sept. 19, 1901. No. 43972 B.

Transformers.

Graphical and Experimental Determination of the Drop of Pressure in Transformers (Graphische und Experimentelle Bestimmung des Spannungsabfalles in Transformatoren). O. S. Bragstad. A comparison of the graphical method with direct experimental measurements, showing the practical accuracy of the former. 3000 w. Elektrotech Zeitschr—Oct. 3, 1901. No. 43977 B.

Voltameter.

The Voltametric Balance (Die Voltametrische Wage). W. Pfanhauser. The cathode is suspended from one arm of a balance, and the disturbance of equilibrium indicates the deposit of metal. 1000 w. Zeitschr f Elektrochemie—Oct. 10, 1901. No. 43984 H.

POWER APPLICATIONS.

Cotton Mill.

Power Plant of the Olympia Cotton Mill. Illustrated detailed description. 3200 w. Engr, U S A—Oct. 15, 1901. No. 43795.

Electric Crane.

A 150-Ton Electric Crane. Illustrated description of the powerful hoisting apparatus installed at the entrance of the new repair basins of the port of Bremerhaven, 36 miles below Bremen. 800 w. Sci Am Sup—Oct. 19, 1901. No. 43826.

Lifting Magnets.

Electric Lifting Magnets. Illustrates and describes the device for handling plates at the New York Shipbuilding Company's yard, at Camden, N. J. 900 w. Sci Am—Oct. 26, 1901. No. 43876.

Mining Plant.

Electricity in Gold Mining. Prof. Wilbar Colvin. Illustrated description of the plant of the Crown Mountain Gold Mining Co. of Dolonega, Ga., in which electricity is the motive power throughout. 1400 w. Sci Am—Oct. 5, 1901. No. 43603.

Trade Dollar Consolidated Mining Company's Electric Plant, Snake River, Idaho. Illustrated description of a water-power development that has proved very successful. 2000 w. Sci Am—Oct. 5, 1901. No. 43601.

Pumping.

Possibilities and Limitations of Electric Pumping. Lewis A. Hicks. Presented at convention of the Pacific Coast Elec. Trans. Assn. Sketches briefly the more important uses of electric power in this connection in California, making comparative statements as to efficiency of performance. Also discussion. 6000 w. Jour of Elec—Sept., 1901. No. 43792.

TRANSMISSION.

Climate.

Climatological Influences and Electrical Transmission. Prof. Alexander G. McAdie. Read at convention of the Pacific Coast Elec. Trans. Assn. Discusses the effect on insulators, generators, lines, switchboards, and the whole plant. Ill. 3300 w. Jour of Elec—Sept., 1901. No. 43791.

Long Distance.

The 142-Mile Electric Power Transmission Plant of the Bay Counties' Power Company, California. J. D. Galloway. Illustrated description of a plant using a pressure of 40,000 to 60,000 volts. All the general features are discussed, especially the remarkable manner in which the current is carried across the Straits of Carquinez, 2000 w. Eng News—Oct. 3, 1901. No. 43665.

Mexico.

The Electrical Transmission of Energy at San Ildefonso, Mexico (Transports Electriques d' Energie de la Compagnie de San Ildefonso à Mexico). E. Pinson. Describes the hydro-electric stations at Monte Alto and at Tlalnepantla, with details of the pipe lines and of the trans-

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mission. 3500 w. Génie Civil—Oct. 12, 1901. No. 43920 D.

Niagara Falls.

The Electric Transmission of Power from Niagara Falls. Lewis B. Stillwell. An illustrated history of the plant and results obtained. 29000 w. Trans Am Inst of Elec Engrs—Aug.-Sept., 1901. No. 43798 D.

Russia.

A Proposed Water Power Electric Transmission Plant for St. Petersburg, Russia. Brief account of the project for the development of extensive water powers near St. Petersburg with electrical transmission to that city. 1100 w. Eng News—Oct. 24, 1901. No. 44011.

MISCELLANY.

Blue Printing.

Blue Printing by Electric Light. S. B. Whinery. Gives illustrated descriptions of the two types of machines for this purpose now on the market, discussing the advantages of each. 4000 w. Pro Engrs' Club of W. Penn—Oct., 1901. No. 43808 D.

Comparative Practice.

A comparison of American and British Methods. Notes on American Electrical Engineering practice as seen from an English point of view. 2000 w. Elect'n, Lond —Sept. 20, 1901. No. 43551 A.

Expositions.

Electrical Installation and Decorative Work in Connection with Exposition Buildings. Luther Stieringer. Read before the Am Inst of Archts. Describes particularly the electric installation at the Pan-American Exposition. 1700 w. Eng Rec —Oct. 12, 1901. No. 43781.

The Glasgow International Exhibition. Sydney F. Walker, An illustrated account of the electrical features. 5200 w. Elec Rev, N. Y—Oct. 12, 1901. No. 43782.

Fire Protection.

Electrical Exhibits at the Fire Protection Exposition (Die Elektricität auf der Feuerschutz-Ausstellung). F. Wilking. Describes electric fire alarms, pumps and other apparatus shown at the Berlin Exposition. 2000 w. Elektrotech Zeitschr—Sept. 19, 1901. No. 43970 B.

Glass Making.

The Electrical Manufacture of Glass (Die Herstellung von Glas auf Elektrischem Wege). Dr. Bermbach. Describing a form of electric furnace adapted for glass making. 2500 w. Elektrochem Zeitschr—Sept., 1901. No 43987 H.

Lightning.

The Protection of Buildings from Lightning. Killingworth Hedges. Read before the Glasgow Congress. Considers the protection usually inadequate, discusses modern practice, American practice, the protection of Westminster Abbey, &c. 6800 w. Elec Engr, Lond—Sept. 27, 1901. No. 43653 A.

Standardization.

The Standardization of Electrical Apparatus. J. T. Broderick. Mr. Broderick's second paper deals with the utility, convenience, and economy of standardization to the purchaser of electrical apparatus. 3500 w. Engineering Magazine—Nov., 1901. No. 44050 B.

GAS WORKS ENGINEERING

Address.

Inaugural Address Before the North of England Gas Managers' Association. Matt. Dunn. An interesting address discussing coal prices, coke sales, conveyors, the gas of the future, coke-ovens, and other important subjects. 7500 w. Jour Gas Lgt—Oct. 8, 1901. No. 43809 A.

Auditing.

Auditing Gas Works Accounts. The present article discusses the function of the auditor principally and the value of efficient auditing. 2700 w. Jour Gas Lgt—Oct. 15, 1901. Serial. 1st part. No. 44040 A.

Blast-Furnace Gas.

Use of Blast-Furnace Gas in Explosion motors. From *Le Génie Civil.* Summary and discussion of the important work of Herr Lürmann. Ill. 3000 w. Sci Am Sup—Oct. 5, 1901. No. 43606.

Calcium Carbide.

Some Notes on Calcium Carbide Manufacture. Reviews an article by M. G. Pradon, of Paris, recently published in the *Zeitschrift fur Calciumcarbid Fabrikation.* 1400 w. Elec Rev, Lond—Sept. 20, 1901. No. 43550 A.

Carbonization.

The Improvement in Carbonization During Recent Years. E. W. Smith. Read before the Eastern Counties' Gas Mgrs. Assn. Also discussion. Gives results at Chelmsford, and considers needed improvements. 4500 w. Gas Wld—Oct. 5, 1901. No. 43748 A.

We supply copies of these articles. See page 483.

Gasholder.

Design of the Proposed Gasholder for Amsterdam (De Constructie van een Outworpen Gashouder voor Amsterdam). J. von Rossum du Chattel. With details of strain diagrams, and special construction to avoid a deep pit in water-bearing ground. 3500 w. De Ingenieur—Sept. 21, 1901. No. 43992 D.

Gas Producer.

Down-Draught Gas Producer (Gazogène à Combustion Renversée). J. Deschamps. A description of the Fangè gas producer, especially adapted for the combustion of wood. 1500 w. Génie Civil—Sept. 14, 1901. No. 43912 D.

Great Yarmouth.

Coal Unloading and Stoking Machinery at Great Yarmouth Gas Works. W. J. Carpenter. An illustrated account of the system introduced, and the results. 3000 w. Gas Wld—Oct. 5, 1901. No. 43747 A.

Growth.

Gas versus Electricity. Alton D. Adams. Gives a comparison of the incomes of these systems, discussing their relative growth during the last ten years. 2300 w. Elec Wld & Engr—Oct. 26, 1901. No. 43898.

Lewis Thompson.

Lewis Thompson and the Early Days of Gas Lighting. A review of the important work of this distinguished chemist. 5500 w. Jour Gas Lgt—Oct. 15, 1901. No. 44039 A.

Retorts.

Further Notes on Retort House Practice. E. H. Earnshaw. Read at meeting of the Am. Gas. Lgt. Assn. Suggestions in regard to the operation of the new and improved methods of coal gas manufacture. 7000 w. Am Gas Lgt Jour—Oct. 21, 1901. No. 43842.

Switzerland.

Results of a Year's Working of the New Gas Works at Zurich, Switzerland. Walter S. Allen. Gives results obtained in the first year's workings of the new plant, as taken from the annual report for the year 1900. 800 w. Am Gas Lgt Jour—Sept. 30, 1901. No. 43518.

Water Gas.

Carburetted Water Gas (Le Gaz a l'Eau Carburé). J. Laverchère. A general study of the generation of water gas beginning with the original apparatus of Gengember in 1819 and continuing to the latest devices. Serial. Part I. 3000 w. Génie Civil—Oct. 12, 1901. No. 43922 D.

INDUSTRIAL ECONOMICS

Australia.

Australian Federation and the British Manufacturer. Stafford Ransome. Points out the difficulties of a satisfactory business with Australia, how some have been removed, and how those remaining may be. 4400 w. Engr, Lond—Oct. 18, 1901. No. 44026 A.

Brazil.

Opening for American Coal in Brazil. A letter from Mr. Castello Branco concerning the opportunity for starting a trade in American coal, giving particulars of points necessary to success. 1800 w. U S Cons Repts, No. 1155—Oct. 7, 1901. No. 43627 D.

Cost Keeping.

The Proper Distribution of the Factory Expense Burden. A. Hamilton Church. Mr. Church's fifth paper is devoted to factory and mass production, and the new machine rate. 3500 w. Engineering Magazine—Nov., 1901. No. 44054 B.

Patents.

The Development and Defects of the American Patent System. C. H. Duell. Extracts from a report by Commissioner of Patents, giving a historical sketch of American practice. 3500 w. Eng Rec—Oct. 26, 1901. No. 43894.

United States vs. German Patent Office Practice. Discusses some of the more obvious differences in the two systems, and the advantage of an understanding to prevent litigation. 2000 w. U. S. Cons Repts, No. 1150—Oct. 1, 1901. No. 43511 D.

Railway Economics.

British Railway Economics. Editorial review of the officially drafted balance-sheet recently issued. 2100 w. Engng—Oct. 11, 1901. No. 43861 A.

Economics of Railway Improvements. W. W. Colpitts. The object of the paper is to outline methods by which the most economical results may be obtained in operation, and to define a basis upon which the yearly value of railway improvements may be quickly and accurately estimated. 6500 w. Can Soc of Civ Engrs. (Adv proof)—Oct. 24, 1901. No. 44047 D.

Strikes.

The Lesson of the Steel Strike. A review of the strike, condemning the leader of the Amalgamated Assn, and commend-

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ing the attitude of the managers of the U. S. Steel Corporation, and pointing the lessons it has taught. 2500 w. Gunton's Mag—Oct., 1901. No. 43633 C.

Works Management.

The Engineering Management of Industrial Works. William D. Ennis. A review of the advances which have been made in industrial management, showing that the best equipment for the executive is found in technical training. 2500 w. Engineering Magazine—Nov., 1901. No. 44055 B.

MARINE AND NAVAL ENGINEERING

Coal Fleets.

The Ohio River Coal Fleets. H. C. Fithian. An illustrated account of the methods of handling the vast quantities of coal distributed via the Ohio River to the West and South. 3000 w. Marine Engng—Oct., 1901. No. 43625 C.

Cobra.

The Cobra Disaster. Discusses this disaster which occurred on Sept. 17, and caused loss of life, and also discusses the construction of this class of vessels and their requirements. 1800 w. Prac Engr—Oct. 11, 1901. No. 43852 A.

The "Cobra" Disaster. Editorial discussion of the verdict of the court-martial, and of this class of vessels. 3700 w. Engng—Oct. 18, 1901. No. 44023 A.

Coast-Lighting.

Lighting of the Chinese Coast. J. R. Harding. Abstract of a paper read before the Glasgow Congress. Brief outline of what has been accomplished. 1000 w. Engng—Sept. 20, 1901. No. 43558 A.

Recent Improvements in the Lighting and Buoying of the Coasts of France. Baron Quinette de Rochemont. Read before the Glasgow Congress. Illustrates and describes recent improvements in burners, discussing means of increasing the illuminating power, the electric lights, incandescent lighting, light-ships, beacon towers, etc., etc. 7000 w. Engng—Sept. 20, 1901. No. 43557 A.

Cruiser.

The Russian 25-Knot Cruiser Novik. A critical discussion of the value of this class of vessels, with illustrations. 2000 w. Engr, Lond—Oct. 11, 1901. No. 43,868 A.

Hulls.

Hull Weights. George Crouse Cook. A practical scientific method of classifying and recording this all important item of ship design, by which the weights of a proposed vessel may be estimated quickly and accurately. 1500 w. Naut Gaz—Oct. 17, 1901. No. 43841.

Ice Yacht.

How to Build a Champion Ice Yacht. H. Percy Ashley. Illustrated detailed description of the construction of the "Aurora." 2800 w. Rudder—Oct., 1901. No. 43655 C.

Propellers.

Propellers for Power Boats. Ernest W. Graef. Some ideas concerning propellers and their proportions relative to the motor, hull, etc. 1800 w. Rudder—Oct., 1901. No. 43656 C.

Reconstruction.

The Reconstruction of the Turkish Battleship "Mesoudie." Illustrates and describes interesting work being carried out at Genoa. 600 w. Engng—Oct. 11, 1901. No. 43863 A.

Report.

Admiral Melville's Report. Advance abstract, the notable features being the statement concerning the failure of the personnel bill, and recommendations in favor of Government participation in a series of important engineering experiments. 3000 w. Ir Age—Oct. 24, 1901. No. 43872.

Salvage.

Salvage Case. Judgment delivered in the Victorian Vice-Admiralty Court with respect to the claim against the owners of the Steamship Alala for £6000 for salvage of that vessel and cargo on the 24th of April. 2800 w. Aust Min Stand—Sept. 12, 1901. No. 43854 B.

Salving of the Steamship Willamette. Illustrates and describes interesting work in salving a vessel when the hull was broken in two parts. Many difficulties were encountered, but it finally left under its own steam. 1900 w. Marine Engng—Oct., 1901. No. 43623 C.

Schooner.

A Seven-Masted Steel Schooner. Illustration and description of a vessel constructed throughout of steel. The vessel is propelled entirely by sails, but has a considerable installment of machinery, steam power being used for the hoisting of anchors and sails. 800 w. Sci Am—Oct. 19, 1901. No. 43824.

Scuttling.

Some Facts Concerning the Scuttling of

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Ships. Lawrence Irwell. Gives several cases of scuttling and the relation to insurance. 2500 w. Marine Rev—Oct. 17, 1901. No. 43834.

Sheathing.

The Question of Sheathing War Vessels. Harry Phelps. Notes showing the opinions abroad; discussing the advantages and disadvantages of sheathing, etc. 2500 w. Naut Gaz—Oct. 10, 1901. No. 43770.

Shipbuilding.

The Development of Ship and Engine Building (Streifzüge durch das Gebiet des Schiff-und Schiffmaschinenbaues). A review of shipbuilding on the Clyde in connection with the Glasgow Exhibition. Two articles. 600 w. Zeitschr d Ver Deutscher Ing—Sept. 14, Oct. 12, 1901. No. 43901 D.

Steamships.

A New Triumph of German Ship-building (Ein Neuer Triumph der Deutschen Schiffbaukunst). A description of the new steamer "Kronprinz Wilhelm," of the North German-Lloyd Steamship line. 1500 w. Stahl und Eisen—Oct. 1, 1901. No. 43952 D.

Shipping.

Foreign Competition in Shipping and Ship-building. An interesting article showing progress made in the different countries, giving diagrams and tables. 3000 w. Engng—Sept. 27, 1901. No. 43,635 A.

Shipping Bounties.

German Shipping Bounties. Editorial discussion of the policy of Germany as shown in a recent report made by W. Ward. 2400 w. Engng—Sept. 20, 1901. No. 43556 A.

Steam Traffic.

Steam Traffic and Trade on the Upper Yangtse. J. Mobsby. Gives a review of all that has been accomplished by steam navigators above Ichang, proving that steamers can descend the rapids, but that it cannot be a commercial success. Suggests means of encouraging trade, and gives information of the cities. 4200 w. Jour Soc of Arts—Oct. 4, 1901. No. 43,749 A.

Submarine.

The First Submarine Boat. From *La Nature*. An illustrated account of the "Nautilus," devised by Fulton, and the experiments made with it one hundred years ago. 1400 w. Sci Am Sup—Oct. 12, 1901. No. 43739.

Tank Steamer.

Tank Steamer Deutschland. C. C. Thomas. Illustrates and describes one of the largest steamers carrying petroleum to German ports. 1600 w. Marine Engng—Oct., 1901. No. 43626 C.

Warships.

The Steamboat Equipment of Warships. E. C. Carnt. Read before the Glasgow Congress. Briefly reviews the history of the application of steam for warship purposes. 3500 w. Engng—Sept. 20, 1901. No. 43559 A.

Warships and Mathematics. Explains a mathematical method of classifying warships. 1900 w. Engr, Lond—Oct. 18, 1901. No. 44027 A.

Yachts.

American Steam Yachts and Their Design. Theodore Lucas. Reviews the principal features of these yachts, the types being classified as fast, medium and slow. Ill. 2000 w. Naut Gaz—Oct. 3, 1901. No. 43667.

Yacht Races.

Fifty Years of "America" Cup Contests. Reviews the contests between the yachts of England and America which have taken place during the last fifty years. Ill. 3300 w. Sci Am—Oct. 5, 1901. No. 43604.

The 1901 Contest for the "America" Cup. An illustrated account of the close contest. 1600 w. Sci Am—Oct. 12, 1901. No. 43737.

MECHANICAL ENGINEERING

AUTOMOBILES.

Burners.

Gasoline and Kerosene Burners. Joseph W. Jones. Advocates the use of petroleum for the purpose of generating heat in steam vehicles, and discusses the defects of the burners now used. 1200 w. Horseless Age—Oct. 16, 1901. No. 43830.

Construction.

Heavier Construction. Hugh D. Meier. Advocating the heavier construction of automobiles and explaining the advantages. 1300 w. Horseless Age—Oct. 16, 1901. No. 43831.

Endurance Run.

Endurance Test Results. Extracts from the committee report. 2000 w. Auto Mag—Nov., 1901. No. 44048 C.

The Endurance Test. Full illustrated account. 8000 w. Auto Mag—Oct., 1901. No. 43610 C.

Explosive Mixtures.

Some Explosive Properties of Gasoline

and Air Mixtures. E. C. Oliver. An account of experiments made imitating as nearly as practicable the conditions existing in the cylinder of a modern gas engine. 1200 w. Horseless Age—Oct. 23, 1901. No. 43873.

Flash Boilers.

The Flash Boiler for Automobiles. Joseph W. Jones. Discusses the advantages of this boiler, and predicts great possibilities, especially in automobile work. 2000 w. Horseless Age—Oct. 2, 1901. No. 43612.

Gasoline Car.

General Specifications for a Gasoline Motor Car. H. Ward Leonard. Gives twenty requirements. 1000 w. Elec Rev, N. Y.—Oct. 5, 1901. No. 43614.

Glasgow Trials.

The Automobile Trials at Glasgow. Alexander F. Sinclair. An account of the five daily runs, the vehicles entered, etc. Ill. 2500 w. Auto Mag—Oct, 1901. Serial. 1st part. No. 43875 C.

Light Car.

The Eastmead-Biggs Voiturette. An illustrated description of a new light car of English manufacture. 1100 w. Autocar—Oct. 12, 1901. No. 43851 A.

The Georges Richard Automobile. Illustrated description of a new type of light automobile of the voiturette class. 700 w. Sci Am Sup—Oct. 26, 1901. No. 43879.

Motor.

The Packard Carriage Single-Cylinder Motor. Hugh Dolnar. Illustrates and describes the leading features of Packard's general arrangement of driving and controlling elements, and the claims of the patent are explained. 4000 w. Auto Mag—Nov., 1901. No. 44045 C.

Newport Races.

The Newport Races. An illustrated account of the races on Aug. 30, 1901. 4500 w. Auto Mag—Oct., 1901. No. 43611 C.

Steam Carriage.

The Reading Steam Carriage. Illustrated detailed description of an interesting car. 1500 w. Autocar—Sept. 21, 1901. No. 43548 A.

Storage Batteries.

Automobile Storage Batteries. Illustrated description in detail of a number of storage batteries designed for automobile work. 5400 w. Elec Wld & Engr—Oct. 5, 1901. No. 43685.

Tour.

A Preliminary New York to Buffalo Tour. S. W. Rushmore. An illustrated account of the run. 2500 w. Auto Mag—Nov., 1901. No. 44044 C.

The 1,000-Miles Tour of "The Powerful." A detailed account of the run made by the "Powerful" electric car from London to Glasgow and Edinburgh. 2500 w. Auto Jour—Oct., 1901. No. 44037 A.

HYDRAULICS.

Flow.

Experiments at Detroit, Mich., on the Effect of Curvature Upon the Flow of Water in Pipes. Discussion of paper by Gardner S. Williams, Clarence W. Hubbell, and George H. Fenkell. 14800 w. Pro Am Soc of Civ Engrs—Sept., 1901. No. 43505 E.

Experiments at Detroit, Mich., on the Effect of Curvature Upon the Flow of Water in Pipes. Continued discussion of paper by Gardner S. Williams, Clarence W. Hubbell and George H. Fenkell. 4000 w. Pro Am Soc of Civ Engrs—Oct., 1901. No. 44003 E.

Plumbing.

Plumbing in the Connecticut Mutual Life Building, Hartford. Illustrated description of a system in which unusual care has been taken to utilize all waste heat for the warming of water. 1800 w. Eng Rec—Oct. 5, 1901. No. 43663.

Pumping Station.

Pumping Station at the South Works of the Illinois Steel Company. Illustrated description of one of the most extensive pumping stations in the United States connected with an industrial works. 1400 w. Ir Age—Oct. 3, 1901. No. 43571.

Pumping.

See Electrical Engineering, Power Applications.

Pumps.

Pumps at the Paris Exposition, 1900 (Die Weltausstellung in Paris, 1900 Pumpen). M. F. Gutermuth. A general review of the pumping machinery at Paris, with comments on points of novelty and interest. 3000 w. Zeitschr d Ver Deutscher Ing—Oct. 12, 1901. No. 43908 D.

Scoop Wheel.

Steam Scoop Wheel at Schellingwonde (Schepradstoomgemaal bij Schellingwonde). H. van Oordt. Illustrated description of large scoop wheels for lifting water about 2 metres for drainage works at Schellingwonde, Holland. 1500 w. De Ingenieur—Sept. 7, 1901. No. 43993 D.

Velocity Measurements.

Current Meter and Weir Discharge Comparisons. Edward C. Murphy. Gives the results of a series of experiments made at the Hydraulic Laboratory, Cornell University, to test the accuracy of velocity measurements obtained with the current meter, used by different methods. 2500 w. Pro Am Soc of Civ Engrs—Sept, 1901. No. 43500 E.

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MACHINE WORKS AND FOUNDRIES.

Ball Bearings.

The Design of Ball Bearings (Beitrag zur Beurteilung von Kugellagern). R. Stribeck. An examination of the proper form of ball race in order to avoid sliding friction. 1000 w. Zeitschr d Ver Deutscher Ing—Oct. 5, 1901. No. 43907 D.

Brass.

Brass Scrap. C. Vickers. Suggestions for the utilization of this material and its treatment. 700 w. Foundry—Oct., 1901. No. 43590.

Castings.

Annealing of Steel Castings. W. M. Carr. Considers such steel as is used in the ordinary branches of the manufacture of castings. Ill. 1000 w. Foundry—Oct., 1901. No. 43589.

Cementation.

The Cementation of Steel and Iron with Gas. C. W. Bildt. From a paper before the Soc. of Swedish Engrs., Stockholm. An illustrated description of the process with statement of advantages. 1600 w. Ir Age—Oct. 3, 1901. No. 43570.

Crane Hooks.

The Strength of Drop-Forged Crane Hooks. John Goodman. An account of tests made of a complete set of crane hooks and the results. Ill. 1600 w. Engng—Oct. 18, 1901. No. 44021 A.

Dies.

Wire Bending and Forming Dies. William Doran. Illustrates and describes work showing what can be accomplished in the bending and forming of comparatively heavy stock in two operations by the use of simple dies. 1000 w. Am Mach—Oct. 3, 1901. No. 43587.

Electric Crane.

See Electrical Engineering, Power Applications.

Flanges.

Standardization of Extra Heavy Flanges. A statement of the dimensions selected for heavy piping in the United States. 500 w. Eng Rec—Oct. 12, 1901. No. 43776.

Foundry Practice.

Iron Foundries and Foundry Practice in the United States. The first of a series of articles giving an illustrated description of the most modern practice in the United States. 2800 w. Engr, Lond—Sept. 27, 1901. Serial. 1st part. No. 43639 A.

Jigs.

A Boring and Facing Jig. Joseph V. Woodworth. Illustrates a jig made for special work. 600 w. Am Mach—Oct. 3, 1901. No. 43584.

Lathe Attachments.

A Multi-Spindle Drilling and Tapping Attachment and Work Fixture, for the Turret Lathe. William Doran. Illustrates and describes designs of the writer. 1600 w. Am Mach—Oct. 3, 1901. No. 43582.

Hobbing Worm Wheels in a Lathe. Illustrates and describes an arrangement for this work. 600 w. Am Mach—Oct. 3, 1901. No. 43586.

Lathes.

Double Boring and Turning Mill. Illustrates and describes a vertical lathe suitable for turning pieces up to 14 in. diameter by 7 in. high. 500 w. Engr, Lond—Oct. 4, 1901. No. 43759 A.

Machine Tools.

Railway Machine Tools at the Paris Exposition, 1900 (Die Werkzeugmaschinen zur Herstellung und Reparatur von Eisenbetriebsmitteln auf der Pariser Weltausstellung 1900). H. Unger. A review of the machine tools exhibited at Paris, with especial reference to their use in railway repair shops. Serial, Part I. 2500 w. Glaser's Annalen—Sept. 15, 1901. No. 43-937 D.

The Tooling of Machines. John Ashford. On the preparing of the tools and the getting of the machines into proper working condition. The present article gives an illustrated and detailed description of selected work. 3500 w. Engng—Oct. 11, 1901. Serial. 1st part. No. 43-858 A.

Mechanical Plant.

The Boys' Industrial School at Lancaster, Ohio. Illustrates and describes the general features of a mechanical plant for a number of detached buildings. 2100 w. Eng Rec—Oct. 5, 1901. No. 43662.

The Mechanical Plant of the Cornell Medical College, New York. Illustrated description of a large ventilating, heating and cooling plant, also operating an extensive electric lighting system, a refrigerating plant, and an hydraulic elevator installation. Full details are given. 6000 w. Eng Rec—Oct. 5, 1901. No. 43660.

Pig Casting.

The Development of the Pig Casting Machine. A. E. Fay. Compares the different makes, showing who conceived the fundamental ideas of the modern machines, and who first put them into practical operation, tracing the development, and describing the latest improvements. 4700 w. Ir Age—Oct. 10, 1901. Serial. 1st part. No. 43682.

Portable Tool.

Universal Portable Machine Tool (Machine Outil Transportable Universelle). F. Morin. An illustrated account

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of the portable tool of Capitaine for drilling, boring, milling, etc. 1800 w. Génie Civil—Oct. 5, 1901. No. 43919 D.

Screws.

Cutting Square Threaded Screws. A. L. de Leeuw. Explains how it is possible to cut a square-threaded screw with anything but square threads, even though the greatest care and best tools be used. Ill. 2000 w. Am Mach—Oct. 17, 1901. No. 43811.

Shop Heating.

Ventilation and Heating in the Denver Shops of the Colorado Road. Illustrated description of a fan system of heating in which a comparatively small number of outlets from the ducts suffices for buildings of large volume. 1600 w. Eng Rec—Oct. 12, 1901. No. 43780.

Shops.

American Machine Shops from a German Viewpoint. Peter Lüders. Mr. Lüders' concluding paper reviews some of the popular fallacies concerning American methods and sets forth their true essentials. 4000 w. Engineering Magazine—November, 1901. No. 44053 B.

A Modern Machine Shop (Eine Moderne Maschinen fabrik). E. Alberts. A description of the new and well-arranged plant of the Aschersleben Machine Works, at Aschersleben, in Prussia. 2000 w. Stahl und Eisen—Sept. 1, 1901. No. 43949 D.

The Westinghouse Electric & Mfg. Co.'s Works. Illustrates and describes interesting things seen at the machine shops of this company. 3000 w. Mach, N. Y.—Oct, 1901. No. 43516.

The Works and Some of the Product of Alfred Herbert, Ltd., of Coventry, England. Illustrated detailed description of large tool-works. 900 w. Am Mach—Oct. 17, 1901. Serial. 1st part. No. 43810.

Steel Rails.

Some Suggestions as to Specifications for Steel Rails. E. F. Kenney. Gives suggestions concerning the composition, blooming, segregation, finishing, straightening and testing. Ill. 2700 w. Eng News—Oct. 3, 1901. No. 43664.

Stereotyping.

The Autoplate—An Automatic Stereotyping Machine. Illustrated detailed description of the machine and its operation. 1500 w. Sci Am Sup—Oct. 26, 1901. No. 43880.

Tools.

Tools for Automobile Tire Valves. Joseph V. Woodworth. An illustrated description of the punches, dies and tools used in making the valves for pneumatic tires. 800 w. Am Mach—Oct. 10, 1901. No. 43700.

Torpedo Works.

The Whitehead Torpedo Works at Fiume. Gives the history of the evolution of the Whitehead torpedo, with illustrated description of the propelling mechanism and other essentials, and of the works. 3500 w. Engng—Sept. 20, 1901. No. 43555 A.

Wrenches.

Making Bicycle Wrenches. Illustrates and describes the making and use of the tools for producing a medium-priced wrench. 1600 w. Am Mach—Oct. 3, 1901. No. 43583.

MATERIALS OF CONSTRUCTION.

Cast Iron.

Notes on the Chemical Constitution of Cast Iron and Steel. A. Carnot and E. Goutal. From *Annales des Mines.* An account of investigations dealing with the elements. 8000 w. Metallographist—Oct., 1901. No. 43849 F.

The Constitution of Cast-Iron, with Remarks on Current Opinions Concerning It. Discussion of Prof. Howe's paper. 2500 w. Trans Am Inst of Min Engrs—Feb., 1901. No. 44062.

The Temperature Limits for the Separation of Graphite from Martensite in Pure Cast Iron. Hugh P. Tiemann. Experimental work done in the Metallurgical Laboratory of Columbia University. 3900 w. Metallographist—Oct., 1901. No. 43850 F.

Flat Plates.

The Strength of Flat Plates. Albert E. Guy. Criticizes an article by George E. Barrett, and compares the formulas given in his article with those of Grashof. 1800 w. Am Mach—Oct. 10, 1901. Serial. 1st part. No. 43699.

Metallography.

The Process of Metallography in 1900. Albert Sauveur. A brief critical review of the year. 5000 w. Metallographist—Oct., 1901. No. 43848 F.

Taylor-White Steel.

High Speed Tool Steel (Schnelldrehstahl). A report of the Berlin section of the Verein Deutscher Ingenieure, upon the capabilities of special German steels for lathe tools; with numerous diagrams. 4000 w. Zeitschr d Ver Deutscher Ing—Sept. 28, 1901. No. 43904 D.

Testing.

The Drop Test Upon Nicked Bars (Essai des Métaux par Choc sur Barreaux Entaillés). A. Dutreux. A review of the paper of Mr. Charpy before the *Société des Ingénieurs Civils de France;* followed by comments by M. A. Pourcel. 2500 w. Génie Civil—Sept. 28, 1901. No. 43917 D.

The Optical Examination of Metallic

We supply copies of these articles. See page 483.

Surfaces (Examen Optique des Surfaces Métalliques). J. Vinsonneau. A discussion of the manner in which approaching rupture may be detected by a critical examination of surface changes in the parts of machines. 2000 w. Revue Technique—Sept. 25, 1901. No. 43927 D.

The Testing of Metals by the Bending of Nicked Bars (Essai des Métaux par Pliage de Barrettes Entaillées). Ch. Frémont. A further discussion of the method of drop tests upon nicked bars, showing that reliable results may be obtained from small test bars. 7500 w. Bull Soc d'Encour—Sept. 30, 1901. No. 43932 G.

POWER AND TRANSMISSION.

Air Compression.

The Hydraulic Compression of Air. William O. Weber. Briefly reviews the various devices used, especially describing the compressors on the Taylor principle. 1400 w. Power—Oct., 1901. No. 43679.

Cableways.

Cableways for Handling Iron Ore. Waldon Fawcett. Illustrates and describes some recent plants of interest. 1700 w. Am Mfr—Sept. 26, 1901. No. 43513.

Chain Driving.

Some Recent Developments in Chain Driving. C. R. Garrard. Read before the Glasgow Congress. States the requirements for chain driving or transmission, discussing the elements of durability, efficiency, etc. Ill. 3000 w. Auto Jour—Oct., 1901. No. 44038 A.•

Conveyors.

Coal Shipping in India. Illustrated description of a coal conveyor designed by Sir Bradford Leslie, particularly with a view to the obtainment of the greatest value from the coolie labor. 2200 w. Ir & Coal Trds Rev—Oct. 18, 1901. No. 44031 A.

The Mechanical Handling of Coal, Ore and Pig Iron. Illustrates some new devices and new applications of old devices, giving descriptions. 5000 w. Ir & Coal Trds Rev—Oct. 11, 1901. No. 43870 A.

Drilling Machine.

The Fosdick and Holloway Drilling Machine. Illustrated detailed description. 1800 w. Ir Age—Oct. 24, 1901. No. 43871.

Gear Teeth.

Some Reasons for Increasing the Obliquity of Involute Teeth. Robert A. Bruce. Discusses the increased strength of teeth as the obliquity is augmented, showing that the efficiency and wearing qualities of the teeth are improved. 2200 w. Am Mach—Oct. 10, 1901. No. 43701.

Power Cost.

An Investigation of the Cost of Power. Clyde D. Gray. An investigation undertaken to get a collection of reliable data on the production, cost and utilization of power by different methods. 4800 w. Jour Fr Inst—Oct., 1901. Serial. 1st part. No. 43693 D.

Power Plants.

Test of an Industrial Power Plant. Gives the results of experiments on the power plant of engine-building works before and after improvement. Taken from paper of James Crighton and W. G. Riddell, presented at the Glasgow Congress. 900 w. Eng Rec—Oct. 12, 1901. No. 43777.

The Power Plant of the Colonial Hotel, Nassau, Bahama Islands. Illustrated description of a small station noteworthy for the garbage crematory connected with the boiler plant and for the system of steam piping. 2000 w. Eng Rec—Oct. 12, 1901. No. 43774.

SPECIAL MOTORS.

Binary Engine.

Combined Vapor Engines (Les Machines à Vapeurs Combinées). A description of the Josse form of binary engine in which the heat of the exhaust steam is used to vaporize sulphur dioxide for use in a second engine. 1200 w. Génie Civil—Sept. 14, 1901. No. 43911 D.

The Waste Heat Engine (Die Abwärne Kraftmaschinen). H. Baum. A description of the Josse and Zimmermann binary engines, using the heat in the exhaust of a steam engine to vaporize sulphur dioxide for use in a second motor. 2000 w. 5 plates. Glückauf—Sept. 7, 1901. No. 43962 B.

Gas Engines.

Second Report to the Gas-Engine Research Committee. Frederic W. Burstall. An account of the tests made, with tabulated results. Ill. 11500 w. Inst of Mech Engrs—Oct. 18, 1901. No. 44046 D.

Studies on Gas Motors (Untersuchungen am Gasmotor). E. Meyer. A full account of investigations made with varying degrees of compression and other working conditions, upon the engine in the mechanical laboratory at Göttingen. The calibration and comparison of indicators is especially discussed. Two articles. 7500 w. Zeitschr d Ver Deutscher Ing—Sept. 14, 21, 1901. No. 43900 each D.

STEAM ENGINEERING.

Boilers.

Modern Boiler Problems. E. D. Meier. Abstract of a paper presented to the N. Eng. Cotton Mfrs. Assn. on the modifications of boiler plants for special services. 2100 w. Eng Rec—Oct. 12, 1901. No. 43779.

On a Form of Double-Tube Boiler.

We supply copies of these articles. See page 483.

John Irving. Read before the Inst. of Naval Architects. Illustrates and describes the construction and performance of these boilers. 1900 w. Prac Engr—Sept. 27, 1901. No. 43650 A.

Steam Boiler and Elevator Defects. An illustrated review of the exhibit made by the Fidelity & Casualty Company of New York at the convention recently held by the Nat. Assn, of Stationary Engrs. in Rochester, of defects found by inspectors. 3600 w. Ins Engng—Oct., 1901. No. 43508 C.

Why Use Yarrow Boilers? (Warum Yarrow Ketels?). A. D. F. W. Lichtenbelt. A study of water tube boilers with especial reference to small straight-tube boilers of the Yarrow type. 3500 w. De Ingenieur—Aug. 24, 1901. No. 43994 D.

See also Mechanical Engineering, Automobiles.

Boiler Test.

Boiler Test at the Dalbusch Mine near Gelsenkirchen (Verdampfungs und Indikatorversuch ausgeführt auf Schacht I der Bergwerksgesellschaft Dalbusch zu Gelsenkirchen). Data and results of tests of engines and boilers of a mine hoisting plant. 1200 w. Glückauf—Oct. 5, 1901. No. 43966 B.

Comparative Practice.

English, American, and Continental Steam Engineering. Philip Dawson. The first of a series of papers treating of modern power-house practice. The present one is devoted to the characteristics of British engine types and practices. 3500 w. Engineering Magazine—November, 1901. No. 44049 B.

Cylinders.

Cylinders for Steam Engines. W. H. Wakeman. Explains plans for determining the diameters of steam engine cylinders for various conditions, presenting examples. 2300 w. Elec, N. Y.—Oct. 30, 1901. No. 44042.

Engine Construction.

Large Work by the Westinghouse Machine Company. Illustrates some of the recent work of this firm on large vertical Corliss engines, giving description. 1200 w. Am Mach—Oct. 3, 1901. No. 43581.

Engines.

Triple-Expansion Engines, South Shields. Illustrated description with report of tests of a surface-condensing, electric-lighting engine. 1800 w. Engr, Lond—Oct. 18, 1901. No. 44028 A.

Flow of Steam.

The Flow of Steam Through Orifices. A review of experiments undertaken by A. Rateau at St. Etienne. 500 w. Eng Rec—Oct. 26, 1901. No. 43888.

Oscillating Engine.

The Oscillating Engine of the Connecticut. Illustrates and describes the changes made in an engine of a Long Island Sound steamboat. 1400 w. Power—Oct., 1901. No. 43678.

Pistons.

The Strength of Pistons (Festigkeit von Scheibenkolben). G. Schwarz. A mathematical examination of the stresses and strains in steam-engine pistons, especially those of the solid disc form. 1000 w. Zeitschr d Ver Deutscher Ing—Oct. 5, 1901. No. 43905 D.

Power House.

The Modern Power House Including the Use of Cooling Towers for Condensing Purposes. J. H. Vail. Calls attention to improvements aiming at economy which may with advantage be introduced. 2500 w. St. Ry Rev—Oct. 12, 1901. No. 43804 C.

Separators.

Positive Steam and Oil Separating and Water Cooling Towers. Francis H. Boyer. Read at meeting of the New England Cotton Mfrs Assn. Illustrates and describes a method of reclaiming water from exhaust steam in almost absolute purity and removing the oil. 1500 w. Power—Oct., 1901. No. 43680.

Steam Plant.

The Steam Plant of the Fall Mountain Electric Light and Power Company. Illustrated description of a 500-H.-P. standby plant with vertical boilers using induced draft, and a special concrete coal bin, built to supplement a hydraulic plant. 800 w. Eng Rec—Oct. 19, 1901. No. 43836.

Steam Pump.

The Pulsometer Steam Pump. Joseph C. Riley. Describes the pulsometer and its operation and gives indicator diagrams, and report of tests. 3800 w. Tech Qr—Sept., 1901. No. 43691 E.

Turbines.

The Steam Turbine. Illustrative description of the De Laval steam turbine, with an account of the results attained and related matter of interest. 1500 w. Sci Am Sup—Oct. 26, 1901. No. 43882.

Valve Gears.

Caring for Corliss Valve Gears. W. H. Wakeman. Suggestions and discussion of some of the features. 1200 w. Engr, U. S. A.—Oct. 1, 1901. No. 43600.

MISCELLANY.

Address.

Presidential address to the Mechanical Science Section of the British Association at the Glasgow Meeting. R. E. Crompton. Considers recent developments in means of locomotion on land, especially the congested street traffic in cities and towns, and means of rapid transit. 6000 w. Engng—Sept. 20, 1901. No. 43580 A.

We supply copies of these articles. See page 483.

Presidential Address before the British Association for the Advancement of Science. Prof. A. W. Rucker. The address deals chiefly with the doubts recently cast on the soundness of the atomic theory, and the accepted theories of science. 11800 w. Engr, Lond—Sept. 13 and 20, 1901. Serial. 2 parts. No. 43579 each A.

Aeronautics.

Count de la Vaulx's Balloon Trip Across the Mediterranean. An account of experimental voyages, especially the most recent one, with illustrations of the balloon. 1300 w. Sci Am—Oct. 26, 1901. No. 43878.

The Cooling of Gas for Inflating Balloons. (Sur le Refroidissement Préalable des Gaz Employés au Gowflement des Ballons). Ch. Lambert. Showing that the removal of contained moisture and other impurities in the gas adds to the length of floating period. 1000 w. Revue Technique —Sept. 25, 1901. No. 43928 D.

The "Santos-Dumont No. 6." from *L'Illustration.* Illustrates and describes some features of the air-ships recently tried. 1100 w. Sci Am—Oct. 5, 1901. No. 43602.

Alcohol Fuel.

Paris Exhibition of Alcohol-Consuming Apparatus. Concerning an exhibition in Paris of inventions for the use of alcohol for illuminating or heating purposes, or for motor power. 1000 w. U S Cons Repts, No. 1161—Oct. 14, 1901. No. 43704 D.

Apprenticeship.

A Systematic Plan of Apprenticeship. Describes the plan at the Baldwin Locomotive Works, with editorial comment. 2000 w. Am Engr & R R Jour—Oct., 1901. No. 43594 C.

Artillery.

Notes on Rapid-Fire Field Artillery. The present article gives an account of the Belgian competitive trials for the choice of a rapid-fire field gun, examining the question from the point of view of the qualities required for good field material. Many illustrations. 3500 w. Jour U S Art—Sept.-Oct., 1901. Serial. 1st part. No. 43829 D.

The Development of the Modern Field Guns. Wilmot E. Ellis. Traces the development of the field gun from 1890-1891 to the present time. 5900 w. Jour U S Art—Sept.-Oct., 1901. No. 43828 D.

Our Improved Artillery (Notre Nouvelle Artillerie). Léo Dex. A discussion of the great advantages obtained by the use of field artillery in which the recoil is taken up in such a manner as to leave the aim undisturbed. 1500 w. Revue Technique —Sept. 25, 1901. No. 43925 D.

Calculating Machines.

The Construction of Algebraic Machines (Sur la Construction des Machines Algébriques). L. Torres. A discussion of the mechanical devices of the author for the summation of series, and for the permutation of roots. Serial, Part I. 5000 w. Revue de Mécanique—Sept. 30, 1901. No. 43930 E + F.

Coal Pockets.

Steel Coal Storage Pockets. H. G. Tyrrell. A brief illustrated description of a new form of construction now used in preference to the pockets built of heavy timber. 1200 w. R R Gaz—Oct. 4, 1901. No. 43666.

Cold Storage.

Cold Storage of Furs and Fabrics. Madison Cooper. Reviews the beginnings of this industry, discussing points connected with it. Also gives extract from an article by Dr. Albert M. Read. Ill. 3000 w. Ice & Refrig—Oct., 1901. No. 43598 C.

Drying Plant.

The Principles and Design of Modern Drying Plant. Shows the demand for artificial drying apparatus, and studies the relations between the vaporized water and the heat required, also other important points. 2600 w. Engr, Lond—Oct. 4, 1901. Serial. 1st part. No. 43758 A.

Exposition.

The Glasgow International Exposition (L'Exposition Internationale de Glasgow). Léon Guillet. A very fully illustrated account of the Glasgow exhibition from a French point of view. 3000 w. Génie Civil —Sept. 21, 1901. No. 43913 D.

Heating.

Distribution of Hot Water. Alton D. Adams. Discussion of the supply of heat by hot water; how to calculate for the degree of heat desired; differences in temperature, etc. 2000 w. Archts & Builds Mag—Oct., 1901. Serial. 1st part. No. 43668 C.

Hot Water Heating in a Chicago Residence. Illustrated description of an open gravity installation with direct and indirect radiation. 1600 w. Eng Rec—Oct. 19, 1901. No. 43840.

The High-Pressure System of Heating by Hot Water. Frederick Dye. An illustrated description of the system, with a statement of the advantages and disadvantages. 3800 w. Plumb & Dec—Oct. 1, 1901. No. 43807 A.

Volume of Water in Hot Water Heating Apparatus. W. M. Mackay. Read before the Am. Soc. of Heat & Ven. Engrs. Discusses the great difference of opinion, and states the volume that has given best results in the practice of the writer. 1500 w. Dom Engng—Oct. 15, 1901. No. 43833 C.

Heating and Ventilating.

Heating and Ventilating the Glasgow Art Galleries. An illustrated description of the plant. The arrangement is on the

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plenum system. 1500 w. Engr, Lond—Sept. 20, 1901. No. 43562 A.

Ventilation and Heating of Buildings. G. H. Bryce. Read at the convention of the Ontario Assn. of Archts. Considers the principles that must be understood to heat economically and efficiently. 3500 w. Met Work—Oct. 19, 1901. No. 43813.

Ventilation and Heating of the Houses of Parliament, England. A general description of the methods now employed for ventilating this structure. 1200 w. Eng Rec—Oct. 26, 1901. No. 43895.

Kinematics.

Binary Systems and Elementary Kinematic Couples (Les Systemes Binaires et les Couples d'Eléments Cinématiques). G. Koenigs. An examination of complete closure, partial closure, and force closure in connection with simple kinematic systems. 1000 w. Comptes Rendus—Sept. 23, 1901. No. 43935 D.

Laboratory.

The Engineering Laboratory of the Technical High School at Stuttgart (Das Ingenieur Laboratorium der Kgl. Technischen Hochschule Stuttgart). C. Bach. With views of the exterior and interior of the building, and plans and sections of the rooms. 3000 w. 2 plates. Zeitschr d Ver Deutscher Ing—Sept. 21, 1901. No. 43902 D.

Safety.

Factors of Safety. Robert Henry Smith. Presidential address, Civil and Mech. Engrs. Soc. Discusses in detail the conditions affecting the factor of safety, the systematic testing of materials, etc. 5000 w. Engr, Lond—Oct. 11, 1901. No. 43869 A.

Telescopes.

Large Astronomical Telescopes (Ueber Grosse Astronomische Fernrohre). Paul Hoppe. A historical review dealing with the mechanical side of the subject, and giving especial attention to the great telescope of the Treptow observatory. Two articles, 5000 w. 2 plates. Glaser's Annalen—Sept. 15, Oct. 1, 1901. No. 43938 each D.

Thermodynamics.

Energy from Terrestial Heat. Jacob T. Wainwright. Discusses inaccuracies in "second law" of thermodynamics, and the means of converting heat of matter into available energy. 3300 w. Ice & Refrig—Oct., 1901. No. 43599 C.

Weighing Machine.

The Blake-Denison Continuous Weighing Machine. An illustrated detailed description. 1100 w. Engng—Oct. 4, 1901. No. 43763 A.

MINING AND METALLURGY

COAL AND COKE.

Bituminous Coal.

The Development of the Bituminous Coal Industry. William Gilbert Irwin. Reviews the history of this industry. 1800 w. Sci Am—Oct. 19, 1901. No. 43822.

Coal Mine.

The New Plant of the Scharnhorst Mine at Brackel near Dortmund (Die Neue Schacht Anlage "Scharnhorst" in Brackel bei Dortmund). F. Schulte. Describing power plant, lighting, coal washing, pumping, etc., of a modern mining installation. 3500 w. 10 plates. Glückauf—Sept. 7, 1901. No. 43961 B.

The Rhine-Elbe Mine of the Gelsenkirchen Mining Company (Die Schachtanlage Rhein-Elbe III. der Gelsenkirchener Bergwerks A-G.). With map and plans of the hoisting machinery, power plant, and general installation. 3000 w. 4 plates. Glückauf—Sept. 7, 1901. No. 43960 B.

Coal Supplies.

Some Practical and Economic Problems in Relation to Our Coal Supplies. J. Stephen Jeans. From the *Proceedings* of the South Wales Inst. of Engrs. Considers the coal reserves, cost of working, waste, coal-cutting machinery, etc. 5500 w. Ir & Coal Trds Rev—Sept. 20, 1901. No. 43563 A.

New Zealand.

New Zealand Coal Mines. Abstracts in reference to the workings at the principal mines and districts visited by the Royal Commission, taken from the report to Parliament. 11600 w. N Z Mines Rec—Aug. 16, 1901. No. 43553 B.

Progress.

Colliery Engineering Progress. C. M. Percy. Reviews the early history of tunneling machines and of the application of compressed air power for running them. 3600 w. Mines & Min—Oct., 1901. No. 43616 C.

Russia.

Russian Coal. Editorial discussing the coals fields of Russia and their development, and the temporary remission of duty on coal imported into certain parts of the country. 1800 w. Engng—Oct. 18, 1901. No. 44024 A.

Scotland.

Some notes on the Output of Coal from the Scottish Coal field. R. W. Dron. Read before the British Assn. Considers the economic circumstances affecting the

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output, and concludes that if wisely handled the coalfields of Great Britain will supply many generations. 2700 w. Ir & Coal Trds Rev—Sept. 27, 1901. No. 43646 A.

Some Notes on the Scottish Coalfields. Observations during a recent visit, describing the character of these coal seams. 2500 w. Ir & Coal Trds Rev—Oct. 4, 1901. No. 43756 A.

Screening.

The Screening of Anthracite. Diagram and description illustrating the system employed in the breakers of the D., L. & W. R. R. Co., and considered typical of the best practice. 1300 w. Col Guard—Sept. 20, 1901. No. 43566 A.

Transvaal.

An interesting Coal Deposit in the Transvaal. An account of the Syferfontein deposit and its discovery. 1300 w. Col Guard—Oct. 11, 1901. No. 43864 A.

Virginia.

Southwest Virginia Coal Belt. Joseph Virgin. An illustrated description of the coal and coke plant of the Virginia Iron, Coal & Coke Co. 1000 w. Mines & Min—Oct., 1901. No. 43618 C.

The History and Conditions of Mining in the Richmond Coal-Basin, Virginia. J. B. Woodworth. Also brief discussion. 2500 w. Trans Am Inst of Min Engrs—Feb., 1901. No. 44065 D.

COPPER.

Losses.

Losses in Copper Smelting. Ronald C. Campbell-Johnston. Discusses the methods employed at Swansea, in Wales, and the modifications that have to be adopted in new countries. 1200 w. B C Min Rec—Oct., 1901. No. 43794 B.

New Process.

Improved Method of Manufacturing Copper, Yellow Metal, and Naval Brass. H. J. Martin. Describes a process consisting of the utilization of the heat, resulting from the refining operation, for the purpose of carrying out the rolling in the "breaking-down" and "drawing-on" stages, thus doing away entirely with any re-heating. 1600 w. Ir & Coal Trds Rev—Sept. 20, 1901. No. 43565 A.

Precipitation.

Copper Precipitation. Detailed account of the processes used in the artificial or mechanical precipitation of copper. 1800 w. Min & Met—Oct. 1, 1901. No. 43621 C.

GOLD AND SILVER.

Assaying.

A Rapid Assay for Silver and Gold in Metallic Copper. George L. Heath. Describes the method, giving results and related information. 2300 w. Trans Am Inst of Min Engrs—Feb., 1901. No. 44061 D.

Brazil.

The Morro Velho Gold Mine, Brazil. Illustrated detailed description of this great gold mine, opened upon the ruins of an old mine which had been worked many years. 6000 w. Eng & Min Jour—Oct. 19, 1901. No. 43844.

Bryan Mill.

The Bryan Mill as a Crusher and Amalgamator. Continued discussion of the paper of E. A. H. Tays. 400 w. Trans Am Inst of Min Engrs—Feb., 1901. No. 44071.

California.

Mining in Lower California. J. D. Lowry. An account of the development, the various enterprises, the minerals found, the topography, characteristics, ownership, laws, &c. 4300 w. Eng & Min Jour—Oct. 12, 1901. No. 43785.

Carolina.

Notes on the Carolina Gold Deposits. Walter Harvey Weed. Concerning the character and treatment of the ore, cyaniding experiments, &c. 1300 w. Eng & Min Jour—Oct. 19, 1901. No. 43846.

Colorado.

The Mining Development of Gilpin County, Colorado. Thomas Tonge. With especial reference to the gold producing districts, showing the evolution of mining methods, and the reduction of costs. 4000 w. Engineering Magazine—Nov., 1901. No. 44052 B.

East Kootenay.

The So-Called "Sand Carbonates" at the Paradise Mine, Windmere District. Charles F. Nicholson. Describes the development work. The "Sand Carbonates" carry about 50 per cent. lead and 60 per cent. silver. Ill. 1100 w. B C Min Rec—Oct., 1901. No. 43793 B.,

Gold.

The Commercial Importance of Gold Mining to Germany (Der Goldbergbau und Seine Wirtschaftliche Bedeutung für Deutschland). B. Knochenhauer. A comparison between the commercial importance of gold, iron and coal mining, showing the necessity of obtaining command of gold mining districts. 2500 w. Glückauf—Oct. 12, 1901. No. 43967 B.

Goldfield.

Phillips River Goldfield. H. P. Woodward. Extracts from a report by the consulting government geologist of Western Australia, relating to this district. 1400 w. Aust Min Stand—Aug. 29, 1901. Serial. 1st part. No. 43675 B.

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Hydraulic Mining.

Note on Hydraulic Mining in Low-Grade Gravel. William H. Radford. A report of actual figures in working property in Northern California. 700 w. Trans Am Inst of Min Engrs—Nov., 1901. No. 44070.

Milling.

Milling Practice at Idaho Springs, Colo. H. Foster Bain. Describes the treatment of pyritic ores and lead ores. Generally the values in the pyritic ores are in gold, and the lead ores in silver. 2000 w. Eng & Min Jour—Oct. 5, 1901. No. 43628.

New Mexico.

The Mogollon Range. Illustrated description of the region near Cooney, New Mexico; the ores yield gold and silver about equally; the production and processes of treatment are discussed. 5300 w. Mines & Min—Oct., 1901, No. 43615 C.

New Zealand.

The Coromandel Goldfields, (N. Z.). J. Malcolm MacLaren. Read before the Inst. of Min. Engrs, (London). The present article describes their geological character. 1200 w. Aust Min Stand—Aug. 22, 1901. Serial. 1st part. No. 43608 B.

Nuggets.

Crystalline Structure of Nuggets. A. Liversidge. Extracts from an address describing some recently obtained nuggets from Victoria and the Klondike and New Zealand. Ill. 1000 w. Aust Min Stand—Sept. 12, 1901. No. 43853 B.

Placers.

Placer Mining in Southern Oregon. Dennis M. Stavel. An account of the mining industry in this region and the working of the placers. Ill. 1600 w. Min Rept—Sept. 26, 1901. No. 43528.

Silver.

The Delamar and the Horn-Silver Mines: Two Types of Ore-Deposits in the Deserts of Nevada and Utah. S. F. Emmons. Illustrated description of deposits in an arid climate presenting interesting structural peculiarities. 7000 w. Trans Am Inst of Min Engrs—Feb., 1901. No. 44569 D.

Transvaal.

Gold-Mining in the Transvaal, South Africa. John Hays Hammond. Describes in detail the Witwatersrand district and its operation, and discusses the mining plants and methods, milling, treatment, &c. Ill. 13700 w. Trans Am Inst of Min Engrs—Feb., 1901. No. 44057 D.

IRON AND STEEL.

America.

American Iron Works and their Appliances (Amerikanische Eisenhütten und deren Hülfsmittel). Ernest Langheinrich. A descriptive review of the American iron industry, including transport and handling of ore, and the general auxiliary appliances to the manufacture. Serial. Part I. 3000 w. Stahl und Eisen—Sept. 15, 1901. No. 43950 D.

Basic Steel.

Basic or Open-Hearth Steel (Thomas oder Martin Flusseisen). F. Grassman. A discussion of the comparative commercial advantages of the basic and acid open-hearth processes for the manufacture of low steel. 1500 w. Stahl und Eisen—Oct. 1, 1901. No. 43953 D.

Blast Furnaces.

Blast Furnaces of American Design at Mariupolsk (Hochofen Amerikanischer Construction auf dem Hüttenwerk zu Mariupolsk). A. Brezgunow. A full account of the extensive iron works on the Sea of Azov, Russia, where the plant is closely modeled after that at Duquesne, Pennsylvania. Two articles. 5000 w. Stahl und Eisen—Sept. 1, 15, 1901. No. 43948 each D.

Cast Steel.

Jupiter Steel. An illustrated description of the manufacture of an exceptionally high grade of cast-steel which is made from wrought-steel scrap, with a mixture of other metals. The patents of Andres G. Lundin. 1100 w. Sci Am—Oct. 12, 1901. No. 43736.

Development.

The Development of the American Iron and Steel Industries. Extracts from a report issued by James M. Swank. 2000 w. Col Guard—Oct. 11, 1901. No. 43866 A.

Electrical Burner.

The Electrical Burner for Blast-Furnaces. F. L. Grammer. Describes the device and its success in burning open tuyeres and cinder holes which have become "frozen." 700 w. Trans Am Inst of Min Engrs—Nov., 1901. No. 44063 D.

Furnace Gases.

The Composition of Blast Furnace Gases (Berechnung der Zusammensetzung der Hochofengase). Bernhard Osann. An examination of the chemical composition and thermal value of blast furnace gases, and their relations to the blast and fuel. 3000 w. Stahl and Eisen—Sept. 1, 1901. No. 43947 D.

Iron Ores.

Geological History of the Hematite Iron Ores of the Antwerp and Fowler Belt in New York. W. O. Crosby. Ill. 2500 w. Tech Qr—Sept., 1901. No. 43689 E.

Luxemburg.

Hydrographic and Geological Notes

We supply copies of these articles. See page 483.

upon the Ore Deposits in Southern Luxemburg (Hydrologisch-Geologischer Beitrag zum Minette Vorkommen in Süd-Luxemburg). K. Limpach. With sections of strata and a colored geological map showing iron ore deposits. 3000 w. 1 plate. Stahl und Eisen—Sept. 15, 1901. No. 43951 D.

Monessen System.

The Monessen System. From an article in *Tin and Terne*, describing the Donner process of rolling black plate. 2500 w. Ir Age—Oct. 10, 1901. No. 43681.

Rod Mill.

Efficiency Test of a Continuous Rod Mill. Describes the plant and method of testing used at a two weeks' test of the plant of the Morgan Construction Co. of Worcester, Mass. Ill. 1200 w. Ir & Coal Trds Rev—Sept. 27, 1901. No. 43647 A.

Slag.

The Composition of Blast Furnace Slag (Zur Constitution der Hochofenschlacke). L. Blum. With analyses of various slags, and a discussion of the conditions of their formation. 2000 w. Stahl und Eisen—Oct. 1, 1901. No. 43954 D.

Steel Works.

The Works and Operations of Messrs. Bolckow, Vaughan & Co., Limited. Illustrated description of the blast furnaces, converting plant, open-hearth steel plant, rail and plate mills, &c. 2500 w. Ir & Coal Trds Rev—Sept. 20, 1901. Serial. 1st part. No. 43564 A.

Strength.

The Effect of Time and Temperature on the Strength of Steel and Iron. Ernest George Coker. Extracts from a paper read before the Canadian Soc. of Civ. Engrs. An account of experimental investigations made in the Testing Laboratory of McGill Univ. 1600 w. Can Engr—Oct., 1901. No. 43576.

MINING.

Accidents.

Accidents in Coal Mines of Pennsylvania. Facts from the report of the Chief of the Bureau of Mines for the year 1900. 4000 w. Mines & Min—Oct., 1901. No. 43619 C.

Air Currents.

Analogies of Electric Currents and Mine Air Currents. Some of the analogies that have been observed are noted, and another article will discuss the important differences. 2000 w. Col Guard—Sept. 27, 1901. Serial. 1st part. No. 43645 A.

Arizona.

Notes on the Geology of Southeastern Arizona. E. T. Dumble. Description based on recent investigations. 8000 w. Trans Am Inst of Min Engrs—Feb., 1901. No. 44058 D.

Explosives.

Explosives in Coal Mines. The new order issued by the Home Secretary adding to the special list of permitted explosives and amending previous orders. 2600 w. Col Guard—Sept. 27, 1901. No. 43644 A.

Nitro-Glycerine Explosives. Remarks on the increased use of these explosives in mining and the safest way of handling and employing them. 1900 w. Aust Min Stand—Aug. 22, 1901. No. 43609 B.

Fire Damp.

Fire-Damp Explosives in the Dortmund District (Die Schlagwetter Explosionen im Oberbergamtsbezirk Dortmund). A review of the explosives during 1900, compared with the barometrical readings, showing the relation between the flow of gas and the atmospheric pressure. 1200 w. 1 plate. Glückauf—Sept. 21, 1901. No. 43963 B.

Fire Protection.

Mine Appliances at the Berlin Fire Protection Exposition (Der Bergbau auf der International Ausstellung für Feuerschulz in Berlin). R. Danilof. With illustrations of nozzles and connections especially adapted for mine service. 1200 w. Oesterr Zeitschr f Berg u Hüttenwesen—Sept. 28, 1901. No. 43958 B.

Ignition.

The Prevention of Defective Firing with Electrical Igniters (Die Beseitigung der Versager bei der Elektrischen Schusszündung). G. A. Meyer. A full review of the methods of electrical ignition of blasting charges in mining, with an examination of the causes of defective ignition. 5000 w. Glückauf—Sept. 28, 1901. No. 43964 B.

Mexico.

Hidalgo del Parral, Chihuahua, Mexico. Illustration and brief description of this town, attracting attention because of the recent mining developments. 1500 w. Eng & Min Jour—Oct. 12, 1901. No. 43784.

Notes on the Mining and Metallurgical Industries of Mexico. Joseph Struthers. Discusses the geology, mineral resources, production, &c., giving illustrated descriptions of important districts. 12800 w. Eng & Min Jour—Oct. 26, 1901. No. 43896.

Prospecting in the Mexican Mineral Country. Theodore S. DeLay. An entertaining account of the life of a prospector in Mexico, with much useful and practical information. 5000 w. Engineering Magazine—Nov., 1901. No. 44056 B.

Mining Machinery.

The Purchase of Mining Machinery.

We supply copies of these articles. See page 483.

Frederick T. Snyder. Discusses the technical and commercial aspects. 2500 w. Min & Sci Pr—Oct. 5, 1901. No. 43702.

Mining Plant.

See Electrical Engineering, Power Applications.

Mining Schools.

The Obligations of Mining Schools to the Industry. James Park. Discusses the knowledge of importance that should be required. 3200 w. N Z Mines Rec—Aug. 16, 1901. No. 43554 B.

Newfoundland.

The History of Mining in Newfoundland. James P. Hawley. A review showing the slow but steady growth. Ill. 7500 w. Can Min Rev—Sept. 30, 1901. No. 43529 B.

Quarrying.

On the Use of the Wire Saw for Quarrying Slate. G. J. Williams. Reprinted from Dr. C. Le Neve Foster's report. Illustrated general description of the wire-saw, and its operation. 3300 w. Quarry—Oct. 1, 1901. Serial. 1st part. No. 43703 A.

Sampling.

Notes on Sampling. Suggestions of importance to secure correct sampling, with discussion of methods. Ill. 2500 w. Min Rept—Oct. 24, 1901. No. 44019.

Shafts.

New Automatic Shaft-Closing Device. A. Padour and V. Sperling. From *Oesterreichische Zeitschrift für Berg und Hüttenwesen.* An illustrated description of the device and its operation. 600 w. Col Guard—Oct. 4, 1901. No. 43761 A.

Shaft-Sinking.

Methods and Cost of Shaft Sinking in the Ruhr District (Leistungen und Kosten beim Schachtabteufen im Ruhrbezirk). L. Hoffmann. Giving tabulated data concerning effectiveness and cost of deepening and lining shafts by various methods; including the Kind-Chaudron system. 4000 w. 1 plate. Glückauf—Sept. 7, 1901. No. 43959 B.

Recent Developments in Shaft Sinking. Paper read by Oberingenieur Riemer at the meeting of the German Min. Assn. at Dortmund. An illustrated account of recent improvements in old methods, and the introduction of new processes. 2200 w. Col Guard—Oct. 4, 1901. Serial. 1st part. No. 43760 A.

Spain.

The Mining Industries of Spain. H. L. Geissel. An illustrated description of works recently visited by the writer, with information obtained. 2500 w. Min & Met—Oct. 1, 1901. No. 43620 C.

Surveying Instruments.

The Evolution of Mine-Surveying Instruments. Dunbar D. Scott. Concluding discussion of paper on this subject. Ill. 3800 w. Trans Am Inst of Min Engrs—Oct., 1901. No. 44059 D.

Timbering.

Some Methods of Timbering and Working Wide Lodes in New South Wales. J. R. Godfrey. An illustrated study of a few typical cases of actual mining where the local conditions modify the methods employed. 1600 w. Min Rept—Oct. 3, 1901. Serial. 1st part. No. 43674.

Ventilation.

The Closing of a Hoisting and Ventilating Shaft at Neumühl near Oberhausen (Der Abschluss des zur Förderung Dienenden Wetterschachtes auf Zeche Neumühl bei Oberhausen). A description of the method by which the outlet of a shaft was closely connected to a ventilating flue and yet retained available for hoisting. 1500 w. Glückauf—Oct. 5, 1901. No. 43965 B.

MISCELLANY.

Alloys.

The Alloys of Antimony andTellurium. Henry Fay and Harrison Everett Ashley. An account of investigations made, describing the methods and apparatus used. Ill. 3300 w. Trans Am Inst of Min Engrs—Nov., 1901. No. 44068 D.

New Researches on the Alloys of Gold, Silver, and Other Matter Found in the Egyptian Tombs. M. Berthelot. Results of examinations made. 1000 w. Sci Am Sup—Oct. 26, 1901. No. 43881.

Aluminium.

The Commercial Importance of Aluminium. Ernest Wilson. Read before the British Assn. Deals with the progress in manufacture, alloys, uses, &c. 3500 w. Engng—Sept. 27, 1901. No. 43638 A.

Carnotite.

The Commercial Preparation of Vanadium and Uranium Compounds from Carnotite. Dr. J. Ohly. Describes the treatment by a continuous process, eliminating the vanadium contents, and recovering the uranium remaining in the residue. 2300 w. Min & Met—Oct. 1, 1901. No. 43622.

Cobalt.

Note on the Occurrence of Cobaltiferous Quartz in the State of Jalises, Mexico. Frederic Chisholm. Brief description of the deposit. 500 w. Eng & Min Jour—Oct. 26, 1901. No. 43897.

Concentrating Machinery.

The Klein Jig and the Klein Classifier. Ferdinand H. Regel. Illustrated description of a jig and an ore-classifier of new design used with galena and other lead

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ores. 800 w. Trans Am Inst of Min Engrs. Nov., 1901. No. 44064 D.

New South Wales.

The Mineral Resources of New South Wales. T. A. Rickard. Review of information given in a recently issued volume by the government geologist, Edward F. Pittman. 3000 w. Eng & Min Jour—Oct. 19, 1901. No. 43845.

Petroleum.

Prospecting for Oil in Colorado. Prof. Arthur Lakes. An illustrated description of the oil springs, the Archuleta oil field, the San Juan River anticline and the Navajo basin. 3400 w. Mines & Min—Oct., 1901. No. 43617 C.

Prospects of the Texas Oil Field. C. F. Z. Caracristi. Considers the actual financial condition of the oil business in Texas, and discusses the scientific side. Ill. and map. 8300 w. Mfrs Rec—Oct. 3, 1901. No. 43578.

The Increased Consumption of Petroleum in California. W. G. Young. Statements concerning the consumption and production of petroleum in this state. 900 w. Eng & Min Jour—Oct. 5, 1901. No. 43629.

Potassium Salts.

The Potassium Salts Industry of Germany. E. Mackay-Heriot. Considers the mining laws, types of occurrences, &c. 2400 w. Eng & Min Jour—Oct. 12, 1901. No. 43786.

Sulphides.

Sulphide Ore Treatment. An account of experimental work carried out by E. A. Ashcroft and James Swinburne. Gives an illustrated description of the modified Phœnix process. 1700 w. Aust Min Stand—Aug. 29, 1901. No. 43677 B.

Tin.

Complex Tin Sulphides. An explanation of methods for their successful metallurgical treatment. 2600 w. Aust Min Stand—Aug. 29. 1901. No. 43676 B.

Tin Mining in Tasmania. Describes the alluvial deposits at Mount Bischoff. 1800 w. Aust Min Stand—Aug. 15, 1901. No. 43607 B.

Wolframite.

Some Recently Exploited Deposits of Wolframite in the Black Hills of South Dakota. J. D. Irving. A study of the geology, occurrence and character of the ore, with report of analysis made. 4000 w. Trans Am Inst of Min Engrs—Feb., 1901. No. 44067 D.

Zinc.

Zinc Production for 1900. Charles Kirchoff. A review of the year. 2200 w. Am Mfr—Oct. 17, 1901. No. 43847.

Zinc and Lead.

Diverse Origins and Diverse Times of Formation of the Lead and Zinc. Deposits of the Mississippi Valley. Charles R. Keyes. A study of these deposits believing them to have a diverse genesis, and discussing the geological date of the formation. 3000 w. Trans Am Inst of Min Engrs—Nov., 1901. No. 44060 D.

The Zinc and Lead Deposits of North Arkansas. John C. Branner. Describes the general geology, the ore deposits in their various forms, and the relation of the geologic structure to the ore-bodies, the composition and quality of the ores, &c. Ill. 6000 w. Trans Am Inst of Min Engrs—Nov., 1901. No. 44066 D.

RAILWAYS AND TRAMWAYS.

CONDUCTING TRANSPORTATION.

Accidents.

The Claim Department. D. W. Patterson. Read before the N. Y. State Ry. Assn. Discusses claims honest and dishonest, the precautions to be taken against accidents, and the need of intelligent employees. 4400 w. St Ry Jour—Sept. 28, 1901. No. 43725 D.

Train Accidents in the United States in August. Record of accidents with notes. 3800 w. R R Gaz—Oct. 18, 1901. No. 43821.

Double-Heading.

Double-Heading with Heavy Engines. Report of a committee of the Central Railway Club, with discussion. 3000 w. R R Gaz—Oct. 25, 1901. No. 44018.

Railroad Operations.

An Analysis of Railroad Operations. S. M. Hudson. Criticises the classification of earnings and operating expenses adopted by the Interstate Commerce Commission and by railroads generally and outlines a classification giving more definite results. 2000 w. Ry Age—Oct. 4, 1901. No. 43631.

Tonnage Rating.

Suggestions for the Establishment of a Practical System of Tonnage Rating. B. A. Worthington. Outlines the system that has been worked out on the Pacific system lines of the So. Pacific Co., giving results for the past year. 1600 w. Am Engr & R R Jour—Oct., 1901. No. 43593 C.

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FINANCIAL.

Accounts.

Capital Accounts from the Viewpoint of Investors and the Public. Col. T. S. Williams. Read before the N. Y. State Ry. Assn. Briefly considers some recent catastrophes in railroad finances due to improper swelling of capital accounts, with general discussion of the subject. 3400 w. St Ry Jour—Oct. 12, 1901. No. 43731 D.

Purchasing and Storeroom Accounting on the Brooklyn Rapid Transit System. A review of the blanks and methods used for properly purchasing, checking, recording and distributing material and supplies. 2200 w. St Ry Rev—Oct. 15, 1901. No. 44007 C.

Report of Committee on Standard Blanks and Accounting for Material and Supplies. F. E. Smith. Presented at convention of N. Y. State St. Ry. Assn. 4000 w. St Ry Jour—Oct. 12, 1901. No. 43732 D.

English Railways.

Tabular Statement of the Expenditure in the Locomotive, Carriage, and Wagon Departments of English Railways. Shows the cost of working and receipts of the eleven principal railways of England. 900 w. Engr, Lond—Oct. 18, 1901. No. 44030 A.

Interurban.

An Interurban Railway as an Investment. Guy Morrison Walker. Discusses the earnings of electric lines as compared with steam roads, the passenger traffic, and the carrying of freight and express. 3000 w. St Ry Rev—Sept. 15, 1901. No. 43537 C.

MOTIVE POWER AND EQUIPMENT.

Apparatus.

Electric Railway Apparatus. Ernst J. Berg. Discusses the characteristics of the various apparatus, and to a certain extent, their limitations. The discussion of storage batteries is omitted. 7000 w. Trans Am Inst of Elec Engrs—Aug.-Sept., 1901. No. 43800 D.

Boosters.

The Use of Series Boosters in Connection with Street Railways. W. J. Davis, Jr. Read before the N. Y. State St. Ry. Assn. Explains the service where the series booster is of special value, explains its requirements, and the limitations of its economical use. 1400 w. St Ry Jour—Sept. 21, 1901. No. 43722 D.

Brakes.

Brakes for Electric Street Surface Cars. Charles R. Barnes. Read before N. Y. State St. Ry. Assn. Reviews the changed conditions in street car operation, and the need of an efficient brake. Comments on some of the recent improvements, and suggests what is needed in a perfect brake. 2500 w. St Ry Jour—Sept. 14, 1901. No. 43719 D.

Brakes in Railroad and Street Car Service. F. M. Nellis. The paper is largely a narration of actual occurrences seen by the writer while serving as traveling inspector and instructor for the Westinghouse Air Brake Co. Also general discussion. 30000 w. N Y R R Club—Sept. 26, 1901. No. 43827.

Edward Hills' Improved Either-Side Brake. An illustrated description of a brake claiming to combine cheapness and efficiency. 2000 w. Col Guard—Oct. 11, 1901. No. 43865 A.

The Siemens Electro-Pneumatic Brake (Le Frein Electro-Pneumatic Siemens). A description of the Siemens electric apparatus for use in connection with air brakes to enable a more prompt setting to be obtained. 2500 w. Revue Technique—Sept. 25, 1901. No. 43926 D.

Brake Rigging.

A Brake Rigging for Double Truck Cars. Myron Rounds. Gives diagram of brake levers, and points out the essential features and reasons for them in a design that has given satisfaction. 1000 w. St Ry Rev—Sept. 15, 1901. No. 43540 C.

Birkenhead, Eng.

Birkenhead Corporation Electric Tramways. Briefly reviews the history of tramways, illustrating and describing their recent electrical equipment. 2500 w. Tram & Ry Wld—Sept. 12, 1901. No. 43543 B.

Brooklyn.

Some Railway Problems of Brooklyn. J. L. Greatsinger. An illustrated article explaining some of the reasons why the service is at present inadequate and the plans being adopted to increase the efficiency. 2000 w. St Ry Jour—Oct. 5, 1901. No. 43713 D.

The Power Stations and Distributing System of the Brooklyn Rapid Transit Company. C. E. Roehl. An illustrated account of the proposed power development, outlining the present equipment. 3500 w. St Ry Jour—Oct. 5, 1901. No. 43716 D.

Bronx.

The Trolley in the Bronx Region. Edward A. Maher. Explains the character of this district, giving illustrations. Its parks draw the pleasure-seekers, and it is rapidly becoming a residential section, through the influence of its trolley lines. 4000 w. St Ry Jour—Oct. 5, 1901. No. 43717 D.

Car Heating.

Notes on Railway Carriage Heating. Notes containing observations of a trip from the North of England to Central

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Italy at Christmas time, noting the sensations of comfort or discomfort over eight lines of railways, the systems of heating, &c. 2000 w. Engr, Lond—Sept. 27, 1901. No. 43643 A.

Car Maintenance.

Car Maintenance on the Metropolitan Street Railway, New York. Thomas Millen. An illustrated article concerning the types and equipment of the cars and their maintenance. 2800 w. St Ry Jour—Oct. 5, 1901. No. 43710 D.

Cars.

New Dining Car on the Denver & Rio Grande Ry. Illustrates and describes a car of fine construction and unique features. 600 w. Ry Mas Mech—Oct., 1901. No. 43572.

100,000 Lbs. Capacity Steel Flat Car—Chicago & Alton Ry. Illustrated detailed description. 500 w. R R Gaz—Oct. 25, 1901. No. 44017.

The Best Form of Car for City Service. Eugene Chamberlin. Read before the N. Y. State Ry. Assn. An illustrated article discussing the most satisfactory vehicle for electric roads in regard to efficiency, economy, convenience and comfort. 2500 w. St Ry Jour—Oct. 12, 1901. No. 43726 D.

The Brill New Semi-Convertible Car. An illustrated description of a new type of semi-convertible car. 2000 w. Ry Mas Mech—Oct., 1901. No. 43573.

Wagons of High Capacity for British Railways. Illustrates and describes two types of cars of new design. 1700 w. Engng—Oct. 18, 1901. No. 44022 A.

Chart.

The Tractive Power Chart. Lawford H. Fry. Gives a chart designed as a time and labor-saving device for use in the calculation of the cylinder tractive power of a locomotive. 1800 w. Am Engr & R R Jour—Oct., 1901. No. 43597 C.

Comparison.

A Three-Year Comparison of Cable, Electric and Horse Traction in New York City. Table showing in detail the earnings and operating expenses for the year ending June 30, 1901, of the Metropolitan St. Ry. Co. of New York, and comparing with the cable and horse traction formerly used. 1500 w. St Ry Jour—Oct. 5, 1901. No. 43718 D.

Conduits.

Electric Conduits. Reviews three articles published in the June number of *Traction and Transmission*. 2000 w. Elec Rev, Lond—Oct. 4, 1901. No. 43754 A.

Couplers.

The Car Coupler Problem. J. E. Thomas. Outlines a design of the writer, stating its advantages. 4500 w. St Louis Ry Club—Sept. 13, 1901. No. 43509.

Croydon.

Croydon Corporation Electric Tramways. An illustrated description of the system, and account of the undertaking of this English borough. 1100 w. Elect'n, Lond—Oct. 4, 1901. No. 43752 A.

Distribution System.

The Electrical Distribution System of the Metropolitan Street Railway Company, New York. Walter A. Pearson. Illustrates and describes the largest polyphase alternating-current distribution for railway purposes yet put in operation. It is notable for the large amount of energy distributed per square mile of territory served. 3500 w. St Ry Jour—Oct. 5, 1901. No. 43709 D.

Draft Appliances.

Locomotive Draft Appliances. The first of a series of articles upon tests made by Prof. Goss of Purdue Univ., to bring the information on this subject up to date and render it applicable to the large locomotives of the present. This number is mainly a discussion of existing information. 2200 w. Am Engr & R R Jour—Oct., 1901. Serial. 1st part. No. 43591 C.

Electric Equipment.

The Electrification of the Metropolitan Railways. An editorial statement of the situation and discussion of the Ganz system. 3300 w. Engng—Oct. 11, 1901. No. 43860 A.

Electric Signals.

The Adoption of Electric Signals on Suburban and Interurban Railways, of Single or Double Track and Their Economy of Operation. William Pestell. Read before the Am. St. Ry. Assn. Discusses the experience of steam roads, the use of the telephone, the systems generally used, types of electric signals, &c. 2200 w. St Ry Rev—Oct. 12, 1901. No. 43802 C.

Havana.

Urban Transportation in Havana. G. F. Greenwood. Illustrated description and particulars relating to the electric railway. 1400 w. St Ry Rev—Oct. 15, 1901. No. 44006 C.

Headlights.

Acetylene Gas Generator for Locomotive Lighting. Illustrated description of a new apparatus in trial on the Chicago & Northwestern. 700 w. R R Gaz—Oct. 11, 1901. No. 43790.

Acetylene Headlights on Locomotives. From a paper by George Landis Wilson, presented at the convention of the Traveling Engrs. Assn., giving considerable information about the use of acetylene for headlights. 1500 w. Ry Age—Oct. 11, 1901. No. 43767.

Locomotives.

American Locomotives for New Zeal-

and. Illustrations and general dimensions of three locomotives furnished for the Government Railways of New Zealand. 1100 w. Ry & Engng Rev—Sept. 28, 1901. No. 43515.

Compound Locomotives in South America. R. Gould. Read before the Glasgow Congress. Some particulars of the results of the compound locomotive on the Buenos Aires Great Southern Railway, Ill. 1700 w. Engng—Sept. 27, 1901. No. 43637 A.

Double Bogie Suburban Locomotive (Machine de Grande Banlieue, à Deux Bogies). G. Du Bousquet. Illustrated description of locomotives designed for the mixed suburban traffic of the Northern Railway of France about Paris. 2500 w. 3 plates. Rev Gen de Chemins de Fer—Oct., 1901. No. 43955 H.

Four-Cylinder Compound Express Locomotive (Locomotive Compound à Grand Vitesse, à Quatre Cylindres). F. Barbier. Description of the engine exhibited at Paris by the Hanover Machine Works, at Linden, near Hanover. 2000 w. 1 plate. Génie Civil—Sept. 28, 1901. No. 43916 D.

Russian Locomotives at the Exposition of 1900 (Les Locomotives Russes à l'Exposition de 1900). R. Godfernaux. Illustrated description of the engines exhibited by the works of Poutiloff, Kolomna, and Briansk. 4000 w. 10 plates. Rev Gen de Chemins de Fer—Aug., 1901. No. 43957 H.

Steam Locomotive for a Speed of 200 Kilometres per Hour (Dampflokomotiven für 200 km St. Geschwindigkeit). R. Sanzin. A discussion of the essentials of a locomotive to make a speed of 125 miles per hour. 2000 w. Glasers Annalen—Oct. 1, 1901. No. 43939 D.

Ten-Wheel Compound Locomotives, Union Pacific Railroad. Brief illustrated description of heavy engines for passenger service. 250 w. Ry & Engng Rev—Oct. 5, 1901. No. 43672.

The Latest North-Eastern Six-Coupled Express Engines. Charles Rous-Marten. Particulars of the actual work performed by these engines. 2700 w. Engr, Lond—Oct. 4, 1901. No. 43757 A.

The Vauclain Compound Locomotive. C. T. Noyse. Read at meeting of the Pacific Coast Ry. Club. Briefly considers the present standing of various types of compound locomotives, and gives information regarding the construction and operation of the Vauclain type. 3000 w. Ry Mas Mech—Oct., 1901. No. 43574.

Vauclain Consolidation Compound Atlantic Type Passenger Locomotive—Chicago, Milwaukee and St. Paul Ry. Illustrated detailed description. 800 w. Am Engr & R R Jour—Oct., 1901. No. 43595 C.

London Tramways.

Electric Tramways of the London United Tramways. The first of a series of articles giving an illustrated detailed description of the conversion and extension of the tramway system, and the introduction of electricity. 1700 w. Elect'n, Lond—Oct. 18, 1901. Serial. 1st part. No. 44035 A.

Manhattan Co.

Manhattan Railway Co., of New York. Brief account of this system which comprises the elevated roads on Manhattan Island, and the Suburban Railroad north of the Harlem River. 1800 w. St Ry Rev—Sept. 15, 1901. No. 43533 C.

Metropolitan Power Plants.

Notes on the Metropolitan Street Railway Power Plants. M. G. Starrett. Gives the results of the operation of the Ninety-sixth street power house, the largest electric railway power house in the world. Ill. 4200 w. St Ry Jour—Oct. 5, 1901. No. 43708 D.

Metropolitan Ry.

The Upbuilding of the Metropolitan Organization. H. H. Vreeland. Briefly reviews the history of the organization and its development, especially the human factor. 3000 w. St Ry Jour—Oct. 5, 1901. No. 43706 D.

The Metropolitan Street Railway System. Discusses the development of the company through consolidations, the history of cable traction and the underground electric conduit, some of the operating conditions, &c. Ill. 4000 w. St Ry Rev—Sept. 15, 1901. No. 43531 C.

Modern Practice.

Notes on Modern Electric Railway Practice. Albert H. Armstrong. A review of some of the more important problems in electric traction now in course of installation or under serious discussion. 4500 w. Trans Am Inst of Elec Engrs—Aug., Sept., 1901. No. 43799 D.

Railway Motor.

The Railway Motor of the Company "La Francaise Electrique" (Les Moteurs de Tramways de la Société "La Française Electrique"). Ilustrating and describing an improved form of enclosed motor for tramway service. 1500 w. Revue Technique—Sept. 25, 1901. No. 43923 D.

Return Current.

The Best Method of Conducting the Return Current to the Power House. E. G. Connette. Read before the Am. St. Ry. Assn. Discusses rail-binding. the trouble experienced, &c., and advocates the use of a jointless and independent metallic return, connected to each rail. 1300 w. St Ry Rev—Oct. 12, 1901. No. 43803 C.

Rolling Stock.

Rolling Stock Construction in Italy. Illustrates and describes recent examples of

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the rolling-stock made at the works of the Officine Meccaniche of Milan. 2700 w. Engng—Oct. 11, 1901. No. 43859 A.

The Rolling Stock of Greater New York. Eugene Chamberlin. An illustrated description of the cars at present operated. 3500 w. St Ry Jour—Oct. 5, 1901. No. 43715 D.

Safety Appliances.

Safety Appliances for Electric Tramways (Sicherheitsvorschriften für Elektrische Bahnanlagen). The adopted report of the committee of the German Electrotechnical Association, providing standards for tramway stations and plants. 2500 w. Elektrotech Zeitschr—Sept. 19, 1901. No. 43971 B.

Sand Dryer.

Improved Sand Dryer and Bin for Locomotive Sand. Drawings and description of a new rotary sand dryer recently put into service on the Chicago, Milwaukee and St. Paul Ry. 400 w. Am Engr & R R Jour—Oct., 1901. No. 43596 C.

Southend-on-Sea.

Southend-on-Sea Electric Tramways. Illustrated detailed description of a recently opened electric tramway. 1400 w. Tram & Ry Wld—Sept. 12 1901. No. 43544 B.

Steam Plants.

Comparative Review of the Steam Plants of Three Large Electric Traction Main Stations in New York City. William Kent. The article criticises the lines that have been followed and suggests means by which considerable economy would have been effected. Ill. 11600 w. St Ry Jour —Oct. 5 1901. No. 43712 D.

Storage Batteries.

The Application of Storage Batteries to the System of the Brooklyn Heights Railroad Company. Franklin E. Morse. Read before the N. Y. State St. Ry. Assn. Describes the storage-battery equipment explaining why it was installed and giving causes and particulars of its successful operation. 2800 w. St Ry Jour—Sept. 21, 1901. No. 43721 D.

Suburban Development.

The Development of Suburban Territory. J. C. Brackenridge. Shows the effect of the trolley roads on the property through which they pass, and the tendency to seek suburban homes when they are accessible. Ill. 2500 w. St Ry Jour—Oct. 5, 1901. No. 43714 D.

Subway.

The New York Rapid Transit Subway. Briefly reviews the steps leading to the work now under construction, and gives an illustrated account of the undertaking. 4200 w. St Ry Jour—Oct. 5, 1901. No. 43711 D.

Third-Rail.

Third-Rail Interurban Railways. Maurice Hoopes. Read at the Rochester meeting of the New York State St. Ry. Assn. States the reasons why third-rail construction is preferable to the trolley where its use is possible, compares cost, notes its disadvantages, and commends the system for a large class of roads. 3700 w. St Ry Rev—Sept. 15, 1901. No. 43542 C.

Tires.

Comparative Study of the Breakages of Tires and of Solid Wheels (Statistique Comparée des Ruptures et Avaries de Bandages et de Roues Pleines). E. Biard. An exhaustive study based on the reports of the German Railway Union from 1887 to 1896. 15,000 w. Rev Gen de Chemins de Fer—Oct., 1901. No. 43956 H.

Tramway Practice.

Recent Tramway Practice. Notes suggested by Mr. James More's paper, read before the Glasgow Congress. 2500 w. Elec Rev, Lond—Oct. 18, 1901. No. 44033 A.

Transmission.

Alternating and Direct-Current Transmission on City Lines. M. S. Hopkins. Read before the N. Y. State St. Ry. Assn. Explains the main features of polyphase alternating transmission with rotary converter sub-stations working in connection with existing direct-current feeder system. 3600 w. St Ry Jour—Oct. 12, 1901. No. 43730 D.

Trolley.

Schnectady-Albany Trolley Line. Illustrates and describes the latest improvements in electric railway engineering as shown in this lien over an old turnpike used as a toll-road over a hundred years ago. 1700 w. St Ry Jour—Sept. 28, 1901. No. 43724 D.

Valves.

Note on Balanced Valves (Note sur les Tiroirs Equilibrés). A communication from the Eastern Railway of France upon the behavior of the balanced slide valves used upon the "Series 3000" locomotives of that road. 3000 w. Revue de Mécanique—Sept. 30, 1901. No. 43931 E+F.

NEW PROJECTS.

Construction.

Current Railway Construction. A review of the construction operations in which the principal railway companies of the United Kingdom are at present engaged. 1500 w. Engng—Oct. 11, 1901. No. 43862 A.

High Speed.

The Electrical High-Speed Experiments at Berlin. Describes the means by which the high-speed problem is to be tested in

We supply copies of these articles. See page 483.

Germany, and the preparations for the experiments. Ill. 1000 w. U S Cons Repts, No. 1154—Oct. 5, 1901. No. 43577 D.

The High Speed Electric Motor Car of the General Electric Company (Der Elektrisch Schnellbahnwagen der Allgemeinen Elektricitats-Gesellschaft). O. Lasche. A German version of the author's paper presented at the Glasgow Engineering Congress. 3000 w. Elektrotech Zeitschr —Sept. 26, 1901. No. 43973 B.

The Siemens and Halske High-Speed Motor Car (Der Schnellbahnwagen von Siemens & Halske A. G. Berlin). W. Reichel. A very full description of the electric motor cars designed for the Marienfeld-Zossen line, with details as to wind resistance, motive power, etc. 7500 w. 1 plate. Three articles. Zeitschr d Ver Deutscher Ing—Sept. 28, Oct. 5, 12, 1901. No. 43903 each D.

Transandine.

Buenos Ayres and Valparaiso Transandine Railway. Arthur H. Sleigh. An account of an important road in South America, the progress of the work, the portion completed, and related matter of interest. Ill. 2000 w. R R Gaz—Oct. 11, 1901. No. 43789.

PERMANENT WAY AND FIXTURES.

Curves.

Transition Curves. C. A. Sundstrom's discussion of a paper by W. B. Lee. 1500 w. Pro Am Soc of Civ Engrs—Oct., 1901. No. 44004 E.

Transition Curves. George D. Snyder. Discussion of a paper on this subject by W. B. Lee. 900 w. Pro Am Soc of Civ Engrs—Sept., 1901. No. 43506 E.

Derailers.

The Derail: Its Past, Present and Possible Future. E. D. Wileman. Discusses the faults of derails in general use, and the perfect derail, its requirements, &c. Ill. 1700 w. R R Gaz—Oct. 11, 1901. No. 43788.

Joints.

Are the Best Results Obtained From the Use of Broken or Square Joints? L. Bradley and F. J. Allen. From a report of a committee presented before the Roadmasters' and Maintenance of Way Assn. 1200 w. Ry & Engng Rev—Oct. 12, 1901. No. 43797.

Oiling.

Oiled Roadbeds. Waldon Fawcett. Describes the operation of oiling a roadbed, illustrating the oil-sprinkling train. Also an account of its successful use on highways. 1100 w. Sci Am—Oct. 26, 1901. No. 43877.

Old Tramway.

The Old Stratford and Moreton Railway. Describes. Gives a descriptive account of a tramroad opened for traffic in 1826. It was designed originally for the taking up of coals, lime, &c., from the canal and river navigation at Stratford for a prosperous agricultural district, and bringing down its produce. 1500 w. Engr, Lond—Sept. 20, 1901. No. 43561 A.

Rapid Transit.

System of the Brooklyn Rapid Transit Co. An illustrated article dealing with some of the operating conditions, traffic across Brooklyn Bridge, consolidations, excursion traffic, &c. 8000 w. St Ry Rev—Sept. 15, 1901. No. 43534 C.

The Rapid Transit Situation in Boston. Louis Bell. Critical comments on the present situation and the outlook for future improvements. 2400 w. Elec Rev, N Y.—Sept. 28, 1901. No. 43517.

The Rapid Transit Tunnel and Railway. A brief illustrated review of the work actually accomplished and a description of the tunnel so far as the plans have been perfected. 3000 w. St Ry Rev —Sept. 15, 1901. No. 43532 C.

Roundhouses.

An Up-to-Date Roundhouse. Illustrated description of a new plant at Collinwood, on the Lake Shore & Mich So. Ry. 700 w. Am Engr & R R Jour—Oct., 1901. No. 43592 C.

Signals.

Automatic Block Signaling on the Boston Elevated. Illustrated description of details taken from a bulletin issued by the Union Switch & Signal Co. 5000 w. R R Gaz—Oct. 11, 1901. No. 43787.

Electric Interlocking for the C., R. I. & P. and the B. & O., at South Englewood, Chicago. Illustrated description of important installations in Chicago. 1500 w. Ry & Engng Rev—Sept. 28, 1901. No. 43514.

English and American Railway Signalling. J. Pigg. Reviews the methods of protection that have been in use at various times, and discusses present practice. Ill. 1700 w. Elec Rev, Lond—Sept. 27, 1901. Serial. 1st part. No. 43652 A.

Maintenance of Automatic Electric Block Signals. H. S. Balliet. From a paper presented at Buffalo meeting of the Ry. Sig. Club. Considers the maintenance of track circuits, signal circuits and the maintenance force. 1700 w. Ry & Engng Rev—Oct. 5, 1901. No. 43671.

The Krizik Block Signal System (Das Block Signal System Krizik). A. Prasch. A description of the improved block system of Krizik, in which the semaphores and switches are operated direct by electric power. Two articles, 6000 w. Zeitschr d Oesterr. Ing u Arch Ver—Sept. 27, Oct. 4, 1901. No. 43940 each B.

Stations.

The New Pennsylvania Station at

We supply copies of these articles. See page 483.

Pittsburg. Illustrated description of a fine structure nearing completion. It combines an office building with commodious arrangements for the traveling public. 1600 w. Ry Age—Oct. 4, 1901. No. 43632.

The New York Central Station, Albany, N. Y. Plan, photographic views and description of a fine structure. 600 w. Archts & Builds Mag—Oct., 1901. No. 43669 C.

Track Construction.

Permanent Way for Electric Tramways. W. Howard Smith. Extracts from a paper read before the Incorporated Assn. of Munic. & Co. Engrs. (England). Considers rails, foundations, paving, &c. 5000 w. St Ry Rev—Oct. 15, 1901. No. 44008 C.

Steel Tie, Concrete Construction. Le Grand Brown. Read before the N. Y. State Ry. Assn. Describes the method adopted in the city of Rochester, N. Y., and gives the cost. Ill. 900 w. St Ry Jour—Sept. 21, 1901. No. 43723 D.

Rails and Track Construction on the Island of Manhattan. W. Boardman Reed. Reviews the various rails used, their advantages and disadvantages, describing the construction, giving cost in New York, &c. Ill. 3800 w. St Ry Rev—Sept. 15, 1901. No. 43541 C.

Track Construction in Brooklyn. E. H. Packe. Illustrated description of the rail section designed by J. C. Brackenridge. 1400 w. St Ry Rev—Sept. 15, 1901. No. 43536 C.

Track Construction on the Brooklyn Rapid Transit System. R. L. Russell. Describes the traffic conditions and the construction. 3400 w. St Ry Rev—Sept. 15, 1901. No. 43535 C.

Tracks.

Track Bonding. Alfred Green. Read before the N. Y. State St. Ry. Assn. Does not think the joints of the rail can be so bonded as to be a perfect success. Discusses the difficulties and the remedy. 1400 w. St Ry Jour—Sept. 14, 1901. No. 43720 D.

Tunnel Alterations.

Proposed Alterations in the Park Ave. Tunnel, New York City. An outline of the proposed changes, with a cross-section of the proposed construction. 700 w. Eng News—Oct. 17, 1901. No. 43817.

Turn-Tables.

Best Method of Operating Turn-Tables by Power. Report of committee to the Assn. of Ry. Supts. of Bridges and Bldgs. Gives tabulated information of turn-tables operated by electricity, gasoline engines, and steam, advising electricity where available. 1800 w. Ry & Engng Rev—Oct. 26, 1901. No. 44043.

Uganda Ry.

The Meridional Rift on the Uganda Railway. Illustrations and description of the temporary inclines on the Kikuyu escarpment of this railway. 700 w. Engng—Sept. 27, 1901. No. 43636 A.

Water Supply.

The Burlington's Water Supply at Galesburg. Illustrated description of a plant to cost $90,000, to supply the locomotives, shops and roundhouses of the C. B. & Q. R. R. 1600 w. Ry Age—Oct. 11, 1901. No. 43766.

TRAFFIC.

Car Mileage.

Car Mileage and How to Arrive at It Easily. J. M. Smith. Read before the N. Y. State Ry. Assn. Describes the forms bearing on this subject used by the Toronto Ry. Co. 1700 w. St Ry Jour—Oct. 12, 1901. No. 43733 D.

Coal Storage.

Coal Storage and Transfer Plant for the Chicago & Erie R. R. at Hammond, Ind. An illustrated description of a plant having a storage capacity of 60,000 tons, and facilities for handling coal in like proportion. 1400 w. Ry & Engng Rev—Oct. 12, 1901. No. 43796.

Differentials.

Railroad Discrimination Against New York, and the Remedy. Herman Conrow. Continued discussion of paper on this subject by Abel F. Blackmar. 5500 w. Pro Am Soc of Civ Engrs—Sept., 1901. No. 43502 E.

Manhattan.

Traffic and Traffic Conditions on Manhattan Island. Historical review of the street railways in New York city, the increase in traffic and growth of the transportation systems from the time of the first stage line. Ill. 4000 w. St Ry Rev—Sept. 15, 1901. No. 43530 C.

Mileage.

Train and Locomotive Mileage Statistics. E. F. Knibloe. Presented at St. Louis meeting of the Am. St. Ry. Assn. Reviews the manner the subject came before the association and the investigations undertaken and methods. 2200 w. Ry Age—Oct. 25, 1901. No. 44009.

New York City.

Traffic Conditions of New York City. Frank R. Ford. A review of the urban transportation problem, explaining the important characteristics and features of special interest, giving tables and diagrams comprising data of the system. Ill. 10700 w. St Ry Jour—Oct. 5, 1901. No. 43705 D.

Oil-Burning.

Oil-Burning Systems for Locomotives. Illustrates and describes the system pat-

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ented by W. N. Best and W. A. Cooper. 500 w. Eng News—Oct. 24, 1901. No. 44013.

Railway Economics.

See Industrial Economics.

Traffic Curves.

Traffic Curves on the New Orleans and Carrollton R. R. A. H. Ford. Discusses how to prepare the traffic curve intelligently so as to show graphically the number of passengers carried throughout the car day, the number of cars provided to carry them, and the adequacy of the accommodation. 1500 w. St Ry Rev—Sept. 15, 1901. No. 43539 C.

MISCELLANY.

Address.

Address of Senator Chauncey M. Depew on Railroad Day at the Pan-American Exposition. Extracts relating to the number of men employed, the amounts paid in wages, for expenses, and for dividends, the change in rates, extent of service, and matters of interest. 2500 w. Ry & Engng Rev—Oct. 5, 1901. No. 43673.

Arbitration.

Arbitration Cases Decided in the High and Appeal Courts of the United Kingdom in Relation to Tramways and Tramcars. J. Neville Porter. Reviews important decisions, stating briefly the facts and the judgments concerning them, and the more significant reasons upon which the decisions are based. 2500 w. Tram & Ry Wld—Sept. 12, 1901. No. 43546 B.

Asia.

Russo-American Railways in Asia. Alexander Hume Ford. A review of the situation, the roads constructed and proposed, machinery needed, &c. 3200 w. Ir Age—Oct. 31, 1901. No. 44084.

Economies.

Goods and Mineral Traffic. Discusses affairs in England, the difficulties in making up heavy trains, and the need of improvements to secure economical handling. 2500 w. Engr, Lond—Oct. 25, 1901. No. 44133 A.

Fire Risks.

Fire Risks of Railways. W. S. Worman. Discusses the causes of fires and the remedies. Also general discussion. 7200 w. W Ry Club—Sept., 1901. No. 43695 C.

Interurban.

The Relation of Interurban Roads to City Roads. Ira A. McCormack. Read before the N. Y. State St. Ry. Assn. Discusses traffic agreements, rails, cars, and various matters, giving the agreement of various cities in the United States. 6600 w. St Ry Jour—Oct. 12, 1901. No. 43729D.

Locomotive Engineering.

Some Modern Tendencies of Locomotive Engineering. Charles Rous-Marten. The first of a series of articles discussing modern tendencies, and the lessons learned by experience. 2800 w. Engr, Lond—Sept. 20, 1901. Serial. 1st part. No. 43560 A.

London.

Mr. Yerkes on the London Situation. A letter to the London *Times*. Relates to the electrification of the Metropolitan Dist. Ry. 1500 w. St. Ry Rev—Sept. 15, 1901. No. 43538 C.

London Tramways.

The Tramways of the London County Council. A resume of the facts relating to the London tramway situation. 2500 w. Tram & Ry Wld—Sept. 12, 1901. No. 43545 B.

Officers.

Some of the Duties of Mechanical Officers. S. P. Bush. An interesting paper discussing these duties and illustrating by actual occurrences the position taken by the writer. General discussion. 10,000 w. W Ry Club—Sept., 1901. No. 43694 C.

Operation.

The Public, the Operator, and the Company. C. S. Sergeant. Read before the N. Y. State St. Ry. Assn. Considers some points in the relations of street railways to the public. 2800 w. St Ry Jour—Oct. 12, 1901. No. 43727 D.

Recent Practice.

Recent Tramway Practice. James More, Jr. Read before the Glasgow Congress. A review of present practice and its results, with remarks on different methods. Ill. 1500 w. Tram & Ry Wld—Sept. 12, 1901. No. 43547 B.

Street Railways.

Street Railways—A Review of the Past and a Forecast of the Future. Robert McCulloch. Read before the N. Y. State St. Ry. Assn. 4700 w. St Ry Jour—Oct. 12, 1901. No. 43728 D.

Train Resistance.

Train Resistance Formulas. John G. Crawford. A discussion of the subject with special reference to the resistance of the portion of the train behind the tender. 1800 w. Eng News—Oct. 31, 1901. No. 44109.

Transfers.

Transfers and Transfer Problems with Special Relation to New York. Oren Root, Jr. The writer considers the extensive transfer system is an important factor in the increased dividend earning power of the road. Describes the conditions in New York and the methods adopted. 3800 w. St Ry Jour—Oct. 5, 1901. No. 43707 D.

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EXPLANATORY NOTE.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* Boston, U. S. A.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Geologist. *m.* Minneapolis, U. S. A.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
Am. Manufacturer and Iron World. *w.* Pittsburg, U. S. A.
American Shipbuilder. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. d Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *qr.* New York.
Architectural Review. *s-q.* Boston, U. S. A.
Architect's and Builder's Magazine. *m.* New York.
Armee und Marine. *w.* Berlin.
Australian Mining Standard. *w.* Sydney.
Autocar. *w.* Coventry, Eng.
Automobile Magazine. *m.* New York.
Automotor & Horseless Vehicle Jl. *m.* London.
Brick Builder. *m.* Boston, U. S. A.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder *w.* London.
Bulletin Am. Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bulletin Scientifique. *m.* Liege.
Bull. Soc. Int. d Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A
Bull. Int. Railway Congress. *m.* Brussels.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Contemporary Review. *m.* London.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Electrical Engineer. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.

Electricity. *w.* London.
Electricity. *w.* New York.
Electrochemist & Metallurgist. *m.* London.
Elektrizität. *b-w.* Leipzig.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Cleveland, U. S. A.
Engineers' Gazette. *m.* London.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penn'a. *m.* Pittsburg, U. S. A.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f. Gewerbe & Bauwesen. *s-m.* Berlin.
Horseless Age. *m.* New York.
Ice and Refrigeration. *m.* New York.
Indian and Eastern Engineer. *m.* Calcutta.
Ingeneria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron & Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Assn. Eng. Societies. *m.* Philadelphia, U.S.A.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery. *b-m.* Fort Monroe, U.S.A.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, Mass.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Madrid Científico. *s-m.* Madrid.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metal Worker. *w.* New York.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* Mexico.
Minerva. *w.* Rome.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Metallurgy. *s-m.* New York.
Mining and Sci. Press. w. San Francisco, U.S.A.
Mining Journal. *w.* London
Mining Reporter. *w.* Denver, U. S. A.
Mitt. aus d Kgl Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. m. Vienna.
Modern Machinery. *m.* Chicago.
Monatsschr. d Wurtt. Ver. f Baukunde. *m.* Stuttgart.
Moniteur Industriel. *w.* Paris.
Mouvement Maritime. *w.* Brussels.
Municipal Engineering. *m.* Indianapolis, U. S. A.
National Builder. *m.* Chicago.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Wochenschr. f. d. Oeff Baudienst. *w.* Vienna.
Oest. Zeitschr. f. Berg- & Hüttenwesen. *w.* Vienna.
Ores and Metals. *w.* Denver, U. S. A.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Power Quarterly. New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Proceedings Engineers' Club. *qr.* Philadelphia, U. S. A.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Progressive Age. *s-m.* New York.
Quarry. *m.* London.
Railroad Digest. *w.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Review of Reviews. *m.* London & New York.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. ed Agr. *b-m.* Catania.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Sanitary Plumber. *s-m.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens' Institute Indicator. *qr.* Hoboken, U.S.A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Telephone Magazine. *m.* Chicago.
Telephony. *m.* Chicago.
Tijds. v h Kljk. Inst. v Ing. *qr.* Hague.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. of Civil Eng. *m.* New York.
Trans. Am. Soc. of Heat & Ven. Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland Glasgow.
Transport. *w.* London.
Western Electrician. *w.* Chicago.
Wiener Bauindustrie Zeitung. *w.* Vienna.
Yacht. *w.* Paris.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a. S.

IMPROVED MACHINERY

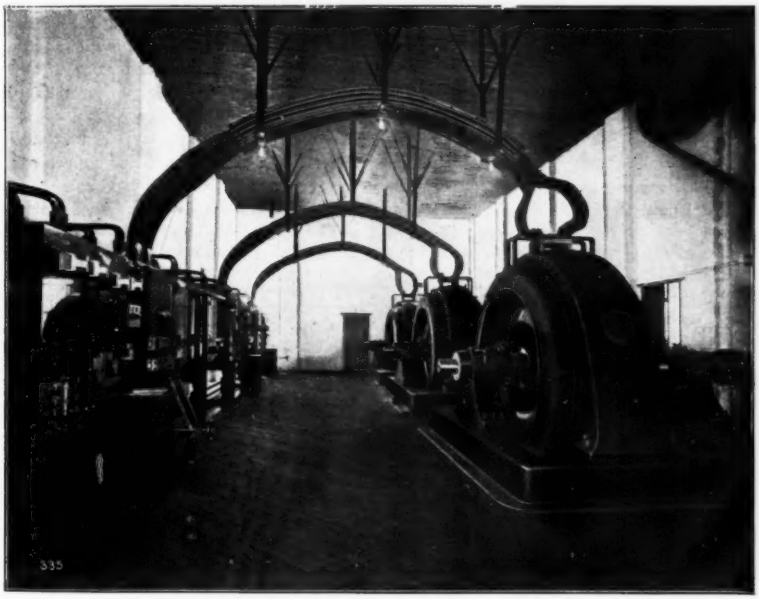
New Processes and New Appliances

The matter here published is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

An Electric Reduction Plant.

AT the falls of the Great Kanawha, some thirty-six miles above Charleston, W. V., is a great industrial enterprise that has in it far more of interest than attaches to the manufacturing of any ordinary article of commerce. It is the Wilson Aluminum Works, which are not, as would be inferred from the name, engaged in the manufacture of any article from the lightest of metals. These works are employed in the reduction of chrome ore and the manufacture of ferro-chromium, which is utilized in the hardening of the steel of which armor plates for war vessels are made.

When the Wilson Company entered the ferro-chromium business they came to deal with the ore so refractory that only electric heat was practicable for its reduction. It became necessary, therefore, to obtain a site for their plant where a great electric current could be secured at a minimum of cost. For this reason the location at Kanawha Falls was chosen. Here New River, which is joined by the Gauley about two miles above, rushes over a precipice some 26 feet high, and is thereafter known as the Great Kanawha. The fall makes one of the finest water powers in the country, the figures of engineers showing that at the



BULLOCK GENERATORS AT WILSON ALUMINUM CO.'S PLANT.

lowest stage 8,000 horse-power of electricity is capable of development. On the top of the solid rock forming the falls, the Wilson Company has built a dam to confine the water to a desired channel, and on the north side an electric plant of 3,000 horse-power of Bullock alternating current generators of the revolving field type has been installed and is now at work. The remainder of the power will be developed by machinery soon to be put in.

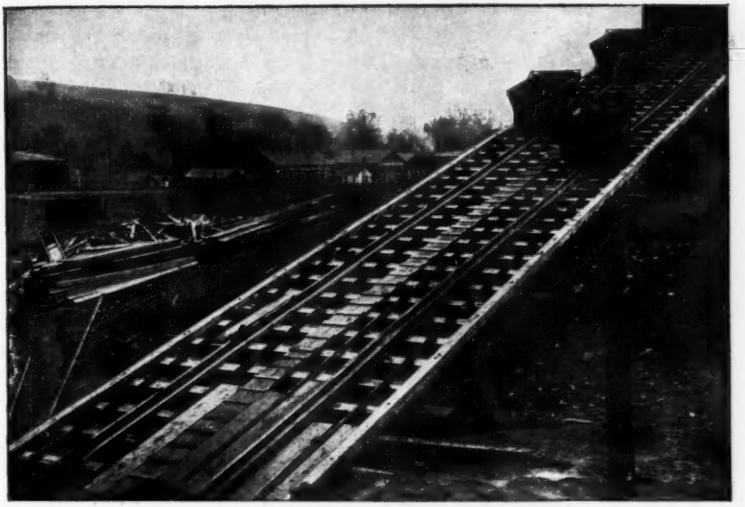
In the intense heat possible from these 3,000 horse-power of electric current the chrome ore is reduced to ferro-chromium, or as it is usually called ferro-chrome.

Aultman Car Hauls and Retarders.

THE machinery of the Aultman car haul and retarder includes two strands of heavy chain, one for the haul up chain, the other, somewhat lighter, for the retarding chain. These chains carry spurs or car pull attachments at intervals to engage with the car axle, if the bottom construction of the car is such as will sufficiently expose the axle. When the axle is not available by reason of construction or the requirements of very heavy duty, a suitable member is affixed to the bottom of the car. The two chains are led over sprocket wheels at the head and foot of the incline. Both chains are connected through their separate gears and pinion shafts, to the same counter shaft. This utilizes much of the power developed by the down going empty cars. The entire apparatus is safe, automatic, self contained, requires no attendance, and cannot get seriously out of order if given an occasional inspection and attention.

The view on this page illustrates a car haul and retarder erected by the Aultman Company, in connection with a complete coal tipple of 800 tons daily capacity, at the Magnolia, Ohio, plant of the National Fireproofing Company. Loaded cars weighing 4,500 lbs. gross are taken from the mouth of the slope to the tipple at the rate of three cars per minute. The haul up chain travels 60 feet per minute. Empty cars are returned from the tipple to the mouth of the slope by the retarding chain. The retarding spurs are 12 feet between centers, and the chain speed is 100 feet per minute. Both haul up and retarding chains are led over knuckle or supplementary head wheels at the top of the incline, to provide a suitable grade for discharging loaded cars, and taking on empty cars without shock or jar to either car or machinery. The length of the haul between centers of head and foot

AULTMAN CAR HAUL AND RETARDER AT MAGNOLIA, OHIO.



AULTMAN CAR HAUL AT MEADOWLANDS, PA.

shafts is 78 feet. The angle of inclination is 22 degrees. Power to drive the car haul is transmitted by one 5/8" wire rope from a line shaft at right angles 250 feet distant. A pawl and ratchet safety on the head shaft provides for contingencies in the case of breaking belts.

The above view is a car haul and retarder erected in connection with a complete coal tipple of 3,000 tons daily capacity, at Meadowlands, Pa., for the Meadowlands Coal Company. This car haul and retarder is 178 feet long. The angle is 20 degrees. Loaded cars weighing 6,000 lbs. gross are taken up the incline at a speed of 70 feet per minute. The empty cars are returned to the mouth of the slope at a speed of 100 feet per minute. In point of general design, this haul is very similar to the one illustrated in Figure 1, but owing to the much heavier duty exacted, all parts are more massive. The factor of safety in each car haul is 10.

The chains used are the Aultman steel forged Jumbo types. The articulating surfaces of these types of chain can be reduced by wear until 30% of the section is removed without impairing the ultimate strength of the chain. A pawl and ratchet safety is used at the head shaft of the haul up chain. This safety also serves the retarding chain, both being connected through their drivers to the same counter shaft.

The first cost of car hauls of this type is very moderate, and they solve the problem of obtaining an elevation sufficient for screening and loading coal at locations where the natural conditions do not favor or provide such necessary elevation.

The Aultman Company of Canton, Ohio, the manufacturers and erectors of the machinery above described, will be pleased to answer more fully any inquiries from engineers and operators of properties where the application of similar apparatus seems possible and practicable.

Expanded Metal Lockers.

THERE is a constantly increasing tendency among employers of labor to provide for the comfort and well-being of their people, and, for every establishment which had a special dressing or wash room arrangement for employes a decade ago, there are a score or more where such accommodations are provided to-day.

In this "industrial betterment," as it is called, the locker was soon admitted to be a necessity, but it was invariably made of wood, for the same reason that wood was

EXPANDED METAL LOCKERS.

formerly used for buildings, namely,—its cheapness and the ease with which it could be worked.

This is, however, the age of steel, so wire lockers soon appeared in the field. They proved to be much better than wooden ones, as they afforded perfect ventilation, and did not warp or crack, but they were expensive and insecure, for it was possible to spring the wires aside, so that the contents of the lockers could be removed.

Merritt & Co., 1020 Ridge avenue, Philadelphia, manufacturers of builders' iron and wire work, devoted much time and thought to the improvement of the wire locker, but realiezd two years ago that it possessed imperfections, which could not be overcome without making the price prohibitive. They then turned their attention to expanded metal, which is a web, formed from a sheet of high grade steel, cut and opened at one operation into diamond shaped meshes of suitable size. This material has no joints or connections, as each sheet is a single piece, and it is, therefore, both stiffer and stronger than any woven wire.

After many experiments, they perfected a locker which has none of the disadvantages of wooden or wire lockers, but possesses all their advantages, together with many which are peculiar to the expanded metal construction.

Having the courage of their convictions, and confident that their quarters would not be large enough for the business which would result, Merritt & Co. rented a large four-story factory for the sole use of their locker department, and equipped it with special machinery, which has enabled them to bring the price of their lockers within the reach of all. The result has far exceeded their expectations, and expanded metal lockers are now in use by many of the largest manufacturing and transportation companies in the United States, as well as by many colleges, gymnasiums, etc. Among those who are using these lockers are the Boston Elevated Railway Company, Yale & Towne Manufacturing Co., Cornell University, General Electrical Co., Wm. Cramp & Sons' Ship and Engine Building Co., and the United States Navy Department.

The success which has attended expanded metal lockers has led the makers to undertake the manufacture of tool room, and elevator enclosures, material closets, etc., of expanded metal, and they also make a full line of sheet steel lockers for use in places where an open mesh locker is not desired.

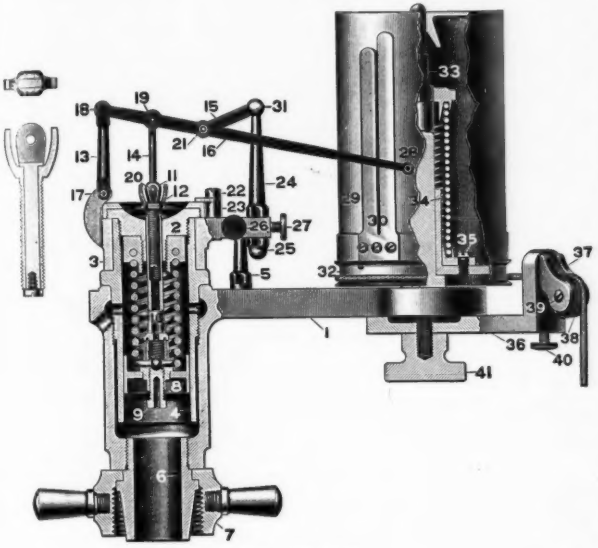
The Star Indicator.

AN exterior view of the Star indicator shows that the instrument is designed somewhat on the lines of the celebrated Thompson indicator, inasmuch as the pencil movement is of the Thompson pattern improved. This movement is chosen because it furnishes the most rigid arrangement of delicate levers for obtaining the desired rectilinear motion of the pencil. It is strong, durable, light in weight, and in all ways satisfactory. The interior design of the indicator is shown herewith in the sectional cut. The lower end of the spring terminates in a simple ball or bead, which has met the test of a long and most successful period of service in other instruments.

Owing to the extreme lightness of this construction, and the fact that it is attained without sacrifice of strength, no arrangement could be more satisfactory. At the same time it furnishes a ball and socket connection between the spring and the piston, which is necessary in all indicators of the Richards type. The form of drum-spring adopted is the helical coil which has been found by long experience, and by accurate tests, to furnish the most uniform tension on the driving cord. It possesses

the desirable features of simplicity and accessibility, and it can be most readily adjusted for differences of tension.

One of the improvements introduced consists in the attachment of the cap at the top of the cylinder to the *interior* shell within which the piston moves, rather than



STAR INDICATOR.

to the outer shell, thus securing and maintaining the most correct alignment for the motion of the piston and its rod. At the same time the interior shell is removable, as in instruments which do not possess this feature. The method of construction is clearly shown in the cut. This arrangement also provides a jacket space filled with working steam completely surrounding the interior shell, and it secures a uniform temperature.

A noticeable feature is the means for unscrewing and removing the cap from the cylinder with the parts attached to it. The cap has a milled edge of the usual construction, but, unlike instruments of previous makes, the edge is protected by a hard rubber non-conducting covering. This covering can be handled with absolute comfort, whereas in the indicators heretofore made it is impossible to unscrew the cap without risk of burning the thumb and finger with the hot metal. Another thing which will be appreciated by those having the active handling of the instrument, is the provision of a vent tube for carrying away the waste steam and hot water which blows by the piston. This tube is attached to the side of the cylinder and it extends a sufficient distance below the body of the instrument to fully clear it, and prevent the hot water which is mixed with the steam from dripping on the hand of the operator while in the act of turning off the indicator cock. In previous designs the operator must often use considerable dexterity if he would avoid getting burnt with the escaping drops of hot water.

The piston rod of the Star indicator is provided with an adjustable swivel-head so planned that the position of the pencil arm can be varied and the atmospheric line drawn at any desired distance from the lower edge of the card, without going to the trouble of removing the piston and its mechanism from the cylinder. It is simply necessary to screw the swivelhead up or down the desired amount, using the thumb and finger.

A new form of detent motion is used in this instrument. The ratchet and pawl have been discarded, giving place to a form of friction clutch which is exceedingly simple and effective. It consists simply of a ball which is thrown into contact with a groove in the circumference of the drum-base.

Most of the details are clearly indicated in the appended cut and all parts are carefully adapted to their respective uses. The frame of the indicator and the coupling are made of unusual strength so as to

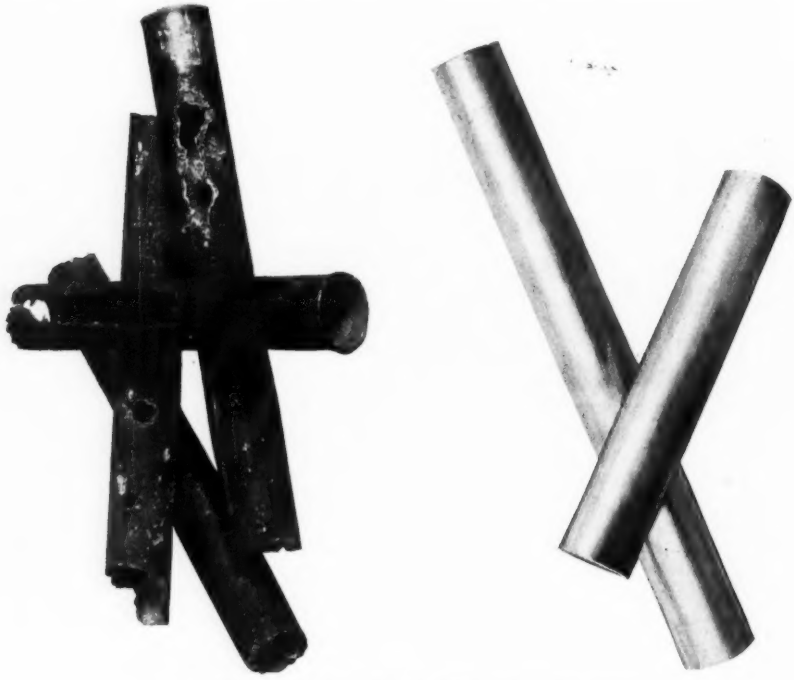
secure simple rigidity where it is most needed. The instrument is nickel plated and fitted in a mahogany case in the usual manner.

Fuller details may be had from the manufacturers, Star Brass Mfg. Co., Boston, Mass.

Non-Corrosive Tubing.

"BENEDICT-NICKEL" seamless tubing is produced by a patented hot rolling process, a single operation transforming a solid cylinderical billet of the heated metal into a tube, the action of the rolls increasing the density of the metal and producing an exceedingly tough and strong tube. The metal is white clear through, substantially the color of pure nickel. It has a tensile strength of fifty per cent. greater than that of brass. It is not liable to crack as it is not sensitive to extremes of heat and cold, and is free from imperfections likely to produce fracture. The non-corrosive qualities of "Benedict-Nickel" render it especially adapted to the manufacture of condenser tubes, and the illustrations shown herewith are brass tubes taken from the American line steamer "St. Paul" contrasted with "Benedict-Nickel" tubes taken from the same steamer after twenty-eight months' service. The tubes were in perfect condition, no evidence of disintegration being found.

Another important application of a tube of this composition is to fixed coolers in breweries. A cleansing flow of water following the cooling operation and a light wiping of the tubes will make them as bright as new, the hot beer having no corrosive effect whatever on the metal. It has been shown that a set of these tubes will outlast several sets if iron, brass, or copper tubing.



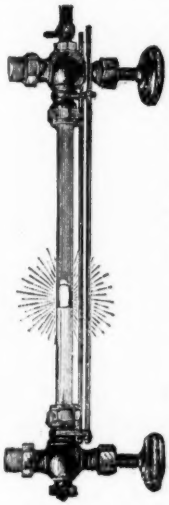
CONTRAST OF BRASS AND NICKEL-STEEL CONDENSER TUBES.

Further information, together with de-

tails of applications may be had by addressing the Benedict & Burnham Mfg. Co., 253 Broadway, New York.

Allen's Indicator Gauge Glasses.

OF the many useful inventions of late years one of the most valuable to steam users is Allen's indicator gauge glass for steam boilers, an illustration of which is shown herewith. The water level in the glass is always readily shown by a floating indicator, the construction of which enables it to always float at the water level in an upright position without aid from the sides of the gauge glass. The indicator's peculiar shape and action has a tendency to keep the gauge glass clean and free from choking, thus preventing many accidents and also much trouble and annoyance to the engineer.



ALLEN'S GAUGE GLASS.

The common practice of placing boilers in out-of-the-way corners, which are frequently so dark as to necessitate the use of artificial light to read the gauges during the day time, is the primary cause of many serious acidents. These gauge glasses are especially adapted to such conditions, as they can be seen clearly and quickly and the use of lights is, in almost every case, unnecessary, and a special light is never needed for the gauges. The special composition of which the indicator is made makes it visible in dark places.

The gauge glasses supplied are made by the oldest and best Scotch manufacturer, and great care is taken in making them, enabling them to bear great variation of temperature and preventing them from hanging color. They are supplied in ⅝" and ¾" diameters and all lengths, and will fit any gauge fittings.

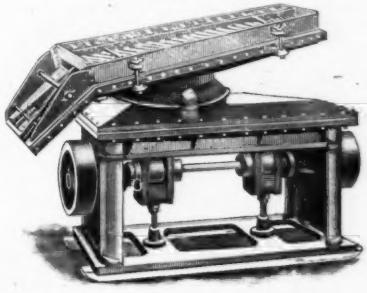
Further information will be supplied by the controlling agents, Contractors' Tool Co., 118 South Sixth St., Philadelphia, Pa.

Hooper Pneumatic Concentrator.

THE General Concentrates Co. build the machine illustrated, for concentrating ores of all grades. This concentrator is remarkable mainly for the extreme simplicity of its construction and the efficiency with which it does it work. It will effectually separate ores into two, three, four or five groups, and will handle ores in which the variation in gravity is less than 1 per cent. In ordinary work, where there is but one mineral to be recovered, the receiving bins can be so located and the ore passing over the screen so guided as to form three groups, one at the extreme right containing only the mineral, the central one being middlings, with a certain proportion of mineral, and which, if necessary, may be passed again through the machine, while the third is tailings, having no value.

Tests of the machine, working upon a mixed lead, zinc and fluorspar ore, in which the highest theoretical saving of zinc was 67 per cent., resulted as follows: Test No. 1, 62.91; Test No. 2, 65.16; Test No. 3, 61.11; the average being 63.06; or within less than 4 per cent. of the highest theoretical saving. Tests made with these same ores on three of the leading concentrating tables using water resulted in zinc concentrates which ran respectively 25, 45 and 45 per cent. On this ore the lead saving by the process here described was 14 per cent. better than the water tables. Results of an equally satisfactory character have been made in the handling of gold, silver, lead and other ores.

The essential features of the machine will be understood from the engraving; it consists of a base, across which extends



HOOPER PNEUMATIC CONCENTRATOR.

the driving shaft, carrying two eccentrics. The stroke of the machine may be varied as demanded by the character of the material by shifting the eccentric sleeve, so as to produce any length of stroke from nothing to the maximum. Upon the right hand end of the shaft is mounted a split pulley so designed and weighted that it may be shifted in order to counterbalance the eccentrics, no matter in what position they may be. The eccentric rods are attached to a rubber diaphragm beneath which is a perforated screen of thin sheet metal. The diaphragm is cut to form flaps, so that upon the down stroke of the eccentrics air is admitted to the chamber. Immediately above and connected with this chamber is a second circular one also provided with a rubber diaphragm arranged in flaps. It will be apparent now that at each stroke of the eccentrics air is admitted through the lower diaphragm, discharged through the upper one, and its force expended upon the cloth underlying the concentrating screen. The upper diaphragm serves also as a stop which prevents dirt being drawn into the air chamber.

The concentrating table is mounted upon a universal joint so that any desired inclination may be given to it. It consists of a frame, under which is stretched the cloth, which covers a grated bed, the gratings being of the same angle as the lower riffles of the concentrating top and which fit accurately on the grate bars. The pulsations of air through the cloth cause it to vibrate between the riffles. The air is also subdivided into small columns which, passing through and in conjunction with the riffles, cause the separation.

Immediately above the cloth and resting upon it is the concentrating table, which consists of two sets of guide strips arranged at right angles to each other and at angles of 45 degrees with the side of the frame. The lower group of strips is about 3-16 inch in height and serves to guide the mineral contained in the ore to the right hand side of the lower or discharge end of the table. The second group of strips rests upon the first, is about 2 inches in height, and guides the tailings to the extreme left.

The principle underlying the operation of the machine will be understood readily. Crushed ore composed of particles having different gravities is separated by agitation, the heaviest seeking the lowest position, the next heaviest being on top, and so on. Bearing this in view it will be understood that the rapid impulses of air through the cloth thoroughly shake up the crushed ore, the heaviest particles of which are separated from the useless parts and are guided by the lower strips to their particular side of the table. At the same time the lighter particles remain on top and are guided by the upper strips to the opposite end of the table. The pitch or inclination forward facilitates the passage of the ore from the feed to the discharge end. Eleven degrees forward is usually the most allowable and 5 degrees sideways the most required in that direction. The side angle has a direct effect on the character of the concentration, some ores requiring more, others less, the exact angle being determined by observing the concentration as the ore passes over the table. This can be determined with reasonable certainty, since the concentrates ought always, with a proper adjustment of the machine, to be clean. These adjustments can readily be made while the machine is running.

Each eccentric is provided with a dial face which indicates the exact length and stroke, from nothing to 1¼ inches, at which the machine may be set. The proper stroke gives the ore a crawling motion, the particles working up and down through each other and seemingly crawling as they travel toward the discharge end. The pulsations range from 350 to 450 per minute, cone pulleys being provided for obtaining the desired variation of speed, though the machines can be set up to suit size of ore at a certain speed and require no cones.

Upon the upper end of the machine is placed an iron hopper provided with a series of gates facing the discharge end. There are three or four gates in this hopper, but the two nearest the right angled side of the top are mainly used. The feed is so regulated that the whole bed of the machine is nicely and evenly covered after a few minutes' running with from ½ to ¾ inch of ore above the cloth.

Detailed drawings and further information can be had from the manufacturers, the General Concentrates Co., 128 Broadway, New York.

NEW CATALOGUES AND TRADE PUBLICATIONS

These catalogues may be had free of charge on application to the firm issuing them. Please mention The Engineering Magazine when you write.

Asbestos Packings.

A brochure referring to the application of asbestos-metallic gaskets in the United States Navy. Size, 3½ by 6 inches, 6 pages. H. W. Johns Mfg. Co.

Belt Conveyors.

A new catalogue illustrating a full line of belt-conveying machinery and illustrating many interesting installations. Size, 6 by 9 inches, 72 pages. By Robins Conveying Belt Co., New York.

Drop Forgings.

A convenient catalogue (10th edition) of extensive variety of drop forgings of iron, steel, copper, bronze, and aluminum. Size, 4½ by 7 inches, 74 pages. J. H. Williams & Co.

Electric Locomotives.

A handsome catalogue in two colors showing an extensive line of electric locomotives for mines, steel works and smelters; also mills, factories, plantations and industrial plants. Size, 6 by 9 inches, 56 pages. The Jeffrey Manufacturing Co.

Electric Motors.

A very complete and highly interesting catalogue of shop and tool equipments with electric motors. Many views are given showing the method of attaching the motor to the machines, and there are many interesting photographs of actual installations. Size, 7 by 10 inches, 102 pages. Northern Electrical Manufacturing Co.

Engine Stop.

Folder showing interior views together with descriptive matter of the Monarch Engine-Stop. Size, 4½ by 6 inches, 4 pages. Monarch Mfg. Co.

Fire Hose.

A catalogue of fire-hose for industrial and municipal service. Size, 32 pages, 6 by 9 inches. Boston Belting Co., Boston, Mass.

Grinding Machinery.

A most complete reference catalogue of an extensive line of emery and corundum goods and grinding machinery. Numerous illustrations and full details are given. Size, 6 by 9 inches, 164 pages. Norton Emery Wheel Co.

Hoisting Engines.

A very elaborate catalogue with embossed cover, illustrating a full line of dredging, pile driving, logging, and mining machinery. Size, 8 by 11 inches, 92 pages. J. S. Mundy.

Locomotives.

"Record of Recent Construction No. 27," being an illustrated paper by Mr. Samuel M. Vauclain on the broad firebox locomotives, read before the Penn. R. R. Y. M. C. A. Size, 6 by 9 inches, 24 pages. Baldwin Locomotive Works.

Machine Tools.

A very handsome album illustrating a large line of machine tools for working plates, bars and structural shapes, not shown in previous catalogues of this company. Size, 9 by 9 inches, 36 pages. Hilles & Jones Co.

Mechanical Stoker.

A handsome illustrated book showing installations of the "American" stoker, underfeed principle. Size, 6 by 9 inches, 148 pages. The American Stoker Co.

Milling Cutters.

Comprehensive and illustrated price-list of milling cutters and similar tools. Size, 60 pages, 3½ by 6 inches. Gay & Ward, Athol, Mass.

Millers Machines.

Catalogue No. 13 showing a full line of millers for the metal trade. The illustrations are excellent and the text furnishes exact information the buyer needs. Size, 6 by 9 inches, 56 pages. The Kempsmith Manufacturing Co.

Molding Machines.

Pamphlet giving full details and description of split pattern molding machines. Size, 6 by 9 inches, 16 pages. The Tabor Mfg. Co.

Motors.

Bulletin No. 206, presenting a list of Lundell electric motors for all purposes. Size, 28 pages, 7 by 9½ inches. Sprague Electric Co., New York.

Ore Crusher.

A well-designed catalogue describing a line of roll jaw crusher and centrifugal rolls. Size, 6 by 9 inches, 40 pages. Sturtevant Mill Co.

Pipe Covering.

Pamphlet describing "Asbestocel" sectional pipe covering, composed of pure asbestos paper, corrugated and formed into cylindrical sections, fitting all standard wrought iron pipe. Size, 8 pages, 3½ by 5½ inches. H. W. John Mfg. Co., New York.

Pneumatic Tools.

A very handsome pamphlet showing a full line of pneumatic appliances together with views of their actual operation. Size, 9 by 12 inches, 12 pages. Chicago Pneumatic Tool Co.

Railroad Cars.

A most interesting catalogue showing details and construction of pressed steel cars for freight and coal service. The views of wrecks in which pressed steel cars have entered are highly instructive. Size, 9 by 12 inches, 78 pages. Pressed Steel Car Co.

Riveting Machines.

Catalogue illustrating in detail a number of portable pneumatic percussion and compression riveting machines for structural elevated railroad work, bridge building, and boiler making. Size, 32 pages, 7 by 9 inches. John F. Alden, New York.

Rubber Goods.

A handsome catalogue in three colors illustrating an extensive line of India Rubber goods for mechanical purposes, manufactured by the Boston Belting Co. Size, 6 by 9 inches, 164 pages. Boston Belting Co.

Rubber Belting.

A handsome catalogue in colors on rubber belting, its care, etc. A vast amount of useful information is given. Size, 44 pages, 6 by 9 inches. Boston Belting Co., Boston, Mass.

Small Tools.

A convenient reference catalogue of small tools, standards, and gauges. Numerous illustrations with dimensions and prices are given. Size, 4½ by 7½ inches, 152 pages. Pratt & Whitney Co.

Spring Calipers.

A pamphlet illustrating and describing a new line of spring calipers, spring dividers, and firm joint caliper. Size, 3½ by 6 inches, 16 pages. Brown & Sharpe Mfg. Co.

Steam Turbine.

Catalogue describing in detail, with illustrations and data, the various types of the De Laval steam turbine. Size, 60 pages, 5 by 7 inches, with folding plate. De Laval Steam Turbine Co., New York.

Tenoning Machinery.

A very handsome brochure in black and orange showing a full line of automatic tenoning machinery. Much interesting information with reference to this class of machines is given. Size, 6 by 9 inches, 24 pages. H. B. Smith Machine Company.

Terra-Cotta.

Pamphlet on fire-proof building material, especially for residences. Shows that handsome and strictly fire-proof residences can be had. Size, 16 pages, 3½ by 6 inches. Henry Masner & Son, New York.

Testing Set.

Folder describing the Queen Evershed portable testing set, consisting of a direct reading ohmmeter and a portable hand dynamo or generator which provides the current necessary to make the test. Size, 4 pages, 8 by 10½ inches. Queen & Co., Philadelphia, Pa.

Tubing.

A small catalogue describing Benedict-Nickel Seamless Tubing, especially adapted to condenser tubes and beer coolers. Size, 4½ by 7½ inches, 32 pages. Benedict & Burnham Mfg. Co.

Unloader.

Handsome catalogue, giving many views of the Lidgerwood rapid unloader, discharging dirt, ballast, etc., from flat cars. Size, 50 pages, 6 by 9 inches. Lidgerwood Mfg. Co., New York.